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# China Report

ECONOMIC AFFAIRS

ENERGY: STATUS AND DEVELOPMENT -- 33

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3 December 1984

CHINA REPORT  
ECONOMIC AFFAIRS

## ENERGY: STATUS AND DEVELOPMENT--33

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## NATIONAL POLICY

### LI PENG ON NATION'S SHORT-TERM, LONG-TERM POWER DEVELOPMENT

Beijing RENMIN RIBAO in Chinese 16 Nov 84 p 1

[Text] XINHUA, 15 Nov--China is now engaged in the preparatory work for the Three Gorges Hydroelectric Power Station on the Chang Jiang. The focus of world attention, this project will have a total installed capacity of 13 million kilowatts with single-unit capacities exceeding 500,000 kilowatts.

This was revealed today by Vice Minister of the State Council Li Peng during a ceremony in honor of the 50th anniversary of the founding of the Chinese Society of Electrical Engineers.

During his speech on China's policy governing electric power construction, Li Peng pointed out that although the short-term focus for electric power construction will be on thermal power, there will be a gradual shift of emphasis to hydropower, with nuclear power playing a supplementary role. At the same time, suiting measures to local conditions, other forms of power, such as wind power, geothermal power, solar power, tidal power, etc., should be developed.

Li Peng stated that the nation's development of thermal power would make it necessary to build the associated power transmission and coal shipping [systems] for pit-mouth power plants and power plants located in ports; in the future it generally will not be necessary to provide oil or gas as fuels for power plants. Major hydroelectric construction will be concentrated on the mid- and upper-courses of the Chang Jiang, the upper course of the Huang He, and the Hongshui He.

CSO: 4013/41

## NATIONAL POLICY

### PREDICTED WINTER POWER SHORTAGE COULD AFFECT LARGE PORTIONS OF NATION

HK011435 Beijing CHINA DAILY in English 31 Oct 84 p 1

[By staff reporter Xu Yuanchao]

[Text] China faces a power shortage this winter that could pose serious problems for Shanghai and nine provinces, according to the Ministry of Water Resources and Electric Power.

The emergency is being worsened by a water shortage and transport problems.

The ministry said an extra 5 million tons of coal would be needed to meet the problem.

The problem has been given close attention by the Chinese authorities, said Wang Ruiqing, deputy director of the ministry's production management department.

He told CHINA DAILY that areas affected would be Shanghai, Jiangsu, Anhui, Hubei, Hunan, Shandong, Jiangxi, Guangdong, Liaoning and Jilin.

There are rich coal deposits in Shanxi, Shaanxi, Ningxia, Heilongjiang and Inner Mongolia. "But transport is so poor that coal produced there cannot be moved out."

Wang said: "Winter is, as always, the peak season for power consumption due to the dwindling daylight hours and the usual rush by some factories to meet their production quotas."

China, which has 4,300 power plants, generated 351.4 billion kilowatt-hours of electricity last year an increase of 7.25 percent over 1982.

The country planned to produce 360 billion kilowatt-hours this year. But it is short 40 billion kilowatt-hours of electricity.

In the fourth quarter of the year, Wang said, it was estimated that the country would produce 87.5 billion kilowatt-hours of electricity, a drop of 4.1 percent compared to the same period last year.

Of the total output, hydropower production would be 16.5 billion kilowatt-hours, a 20-percent drop over the same period last year.

He said: "China's 11 major reservoirs are holding 25 percent (about 9.2 billion cubic meters) less water than the corresponding period last year."

He estimated that China's hydropower plants could produce 80 billion kilowatt-hours of electricity this year. The rest was to have been supplied by thermal power plants, but the plan had been disrupted by the coal difficulties.

Wang described the power shortage as a long-term problem.

Experts argued that the power shortage over the past decade was basically caused by energy waste and insufficient investment, as well as the construction of small power plants during the "cultural revolution."

China's power production cannot keep pace with the overall growth of the national economy.

The government has invested more than 6 billion yuan in capital construction for the power industry this year.

In 1982 China produced 666 million tons of coal, of which only 6.73 million tons were exported.

CSO: 4010/22

## NATIONAL POLICY

### THE DEVELOPMENT OF THE GUIZHOU ENERGY BASE

Beijing ZHONGGUO MEITAN BAO in Chinese 11 Jul 84 p 2

[Article by Gu Naimian [7357 0035 4875], Chief of Coal Industry Department of Guizhou and Director of Guizhou Coal Industry Corporation, and Gao Hongqing [7559 1347 1987]: "Guizhou: Energy Base of the South"]

[Text] Coal and hydropower resources in Guizhou are abundant, ranking first in the whole country. But since the province is located in the Yunnan-Guizhou Plain, large-scale development of coal is limited by transportation factors. As a result, comprehensive development of coal and electricity, the realization of "transporting western coal to the east" and "transmitting western electricity to the east" and turning Guizhou into a regional energy base in the south have a profound significance to promoting Guizhou's economy as well as the economic development of the provinces and regions of Guizhou, Guangdong-Guangxi, and Hunan-Hubei.

Guizhou's coal and electric power industries have now begun to take shape. In 1983 raw coal production in the province as a whole was over 18,000,000 metric tons for a 60-fold increase over the early period of Liberation; planned output by the year 2000 is 50,000,000 metric tons for a 2.6-fold increase over 1980. The present installed capacity of power generation in the province as a whole exceeds 1,500,000 kilowatts with an annual power output of more than 6,000,000,000 kilowatt-hours, respectively a 7- and 8-fold-increase over the early period of Liberation. The planned installed capacity by the year 2000 exceeds 7 million kilowatts with an annual power output of more than 30,000,000,000 kilowatt-hours, which will realize "transmitting western electricity to the east" and give full play to Guizhou's energy potentials.

Guizhou has vast coal reserves. It's variety of coal is complete, the quality of coal is good and the deposits are shallow and easily exploitable. Confirmed reserves in the province as a whole are close to 50,000,000,000 metric tons, ranking it first south of the Chang Jiang and fourth in the nation. But as transportation factors are not compatible, it is difficult for the state to spend large sums of money on building railways in the near future. It is necessary to proceed from Guizhou's realities. On one hand we should rely on the Guizhou-Kunming line which is being electrified and the Hunan-Guizhou line which is planned for electrification; the highways between Panxian and Guizhou and Baise in Guangxi and between Xishui and Chishui for which feasibility study is being conducted; and the water transportation which is planned

for extension. On the other hand, we must vigorously develop coal dressing, build pit-mouth power plants, and realize the combination of coal and electric power. Currently there are five coal dressing plants in the province as a whole with a designed capacity of 5,300,000 metric tons. When the Panbei, Dawan, Dahe, Lindong and other coal preparation plants are completed around the year 1990, wash capacity in the province will reach 20,000,000 metric tons. We can also gradually ship out fine coal, washed lumps and anthracite lumps, use mixed coal and medium coal for local power generation after washing, turn coal into electric energy and coordinate with the transmission of hydro-electric power to the east. This will reduce the pressure of transportation and increase social and economic results.

In building pit-mouth power plants in Guizhou, first, investment is low; second, they take up little space; third, underground and surface water is abundant in the mining area and the consumption of water by the power plants can be easily resolved; fourth, western Guizhou is vast in area and sparsely inhabited so that plant location and environmental protection problems can be easily resolved.

Hydropower resources in Guizhou are mainly distributed in the river basins of the Wu Jiang, Nanpan Jiang, and Beipan Jiang, and the exploitable capacity province-wide is about 13,000,000 kilowatts, which ranks sixth in the nation. The Wu Jiang cuts across central Guizhou. Its geographical location is favorable and it has been nationally ranked as a key hydropower construction base. At present, construction conditions of the Wu Jiang are ripe. The preliminary plan is to construct 12 cascade power stations with an installed capacity of 6,000,000 kilowatts and an annual power output of more than 30,000,000,000 kilowatt-hours. Although hydropower is economical, seasonal effects are great so that it is necessary to rely on thermal power to supplement its deficiencies and to combine hydropower and thermal power.

Comprehensive development of coal and electric power in Guizhou will promote the development of communications and transportation, chemical industry, high-energy consumption industry, local industry and electric power industry. This will give immense impetus to the development of the national economy of the southwest, Guangdong-Guangxi, and Hunan-Hubei.

#### Local Coal Mines Have Good Prospects

The characteristic of Guizhou's coal resources is its abundant reserves. It is rich in exposed coal, has resources that suit large-scale exploitation by the state and has abundant resources that suit the construction of small and medium-sized local coal mines. At present, in the province as a whole, there are 65 state-run local coal mines and 4,320 coal mines run by communes and brigades. In 1983 local mines produced a total of 11,540,000 metric tons, about 62.5 percent of the total provincial output, which exceeded the annual quota by 3,040,000 metric tons and set of new record. Moreover, local coal mines are widely distributed throughout Guizhou, giving them an important role in developing the provincial economy and in satisfying the daily need for coal by the people. At the same time, it annually ships out more than 1,000,000 metric tons of coal to support other provinces and regions including Guangxi, Yunnan, and Sichuan.

Since the Third Plenary Session of the 11th Party Central Committee, local coal mines have received even greater attention. The provincial government has allocated funds to give particular support to the technological transformation of a number of pits including the Longchang Coal Mine in Qiandongnan Miao-Dong Autonomous Prefecture and the Huavo Coal Mine in Qianxi and has paid particular attention to 9 pairs of complementary projects under construction. Of these, the Chajiao Coal Mine on the banks of the Chishui He and the Jiaotong Coal Mine in Renhuai which exclusively supplies coal to maotai breweries have been completed; the Malin Coal Mine in Xishui is near completion, thus forming the key local coal mines in northern Guizhou. Through safety in the supplementation of shortages, a permanent power source for over 92 percent of the mines has been assured and new conditions have been initiated for the realization of safety in production and the improvement of the level of mechanization.

In developing its local coal industry, Guizhou on one hand implements the guiding principle of "support, transform, consolidate, and integrate" to promote healthy development of small coal mines in rural areas and towns. On the other hand, it selects and preferentially develops sectors which are close to railroads, rivers, and major highways and which have good geological conditions for building a group of local mines. It has planned to build several small local commercial coal bases during the periods of the 7th and 8th Five-Year Plans in order to provide more commercial coal to southern provinces and regions which are short of coal.

#### A Brief Introduction To Guizhou's Coal Industry

Guizhou's coal fields have a total area of 100,000 square kilometers, 40 percent of the total area of the province. Estimated reserves are 180,000,000,000 metric tons, with verified reserves of 49,100,000,000 metric tons, primarily concentrated in the Liupanshui, Zhijin, and Nayong areas in western Guizhou. The quality of coal is good, variety is complete, deposits are shallow and Guizhou has always enjoyed the title "sea of coal in the southwest" and ranks first among southern provinces and regions. It now has 3 unified distribution mines in Liuzhi, Panjiang, and Shuicheng, 21 pairs of mining pits, a designed annual output of 10,000 metric tons, and 2 pairs of mines under construction with a designed capacity of 1,950,000 metric tons. It has also constructed a group of coal machinery plants, construction materials plants, thermal engineering plants, and coal-washing plants. There are now five coal-washing plants with an annual capacity of 5,300,000 metric tons.

Guizhou's local coal mines are substantial in capacity. There are 65 state-run local mines and 4,320 mines run by commune brigades. The coal output last year was 11,540,000 metric tons, 62.5 percent of the total provincial output.

Apart from use by the province itself, Guizhou coal primarily supports the Panzhihua iron and steel base as well as the provinces and regions of Sichuan, Yunnan, Guangxi, and Guangdong.



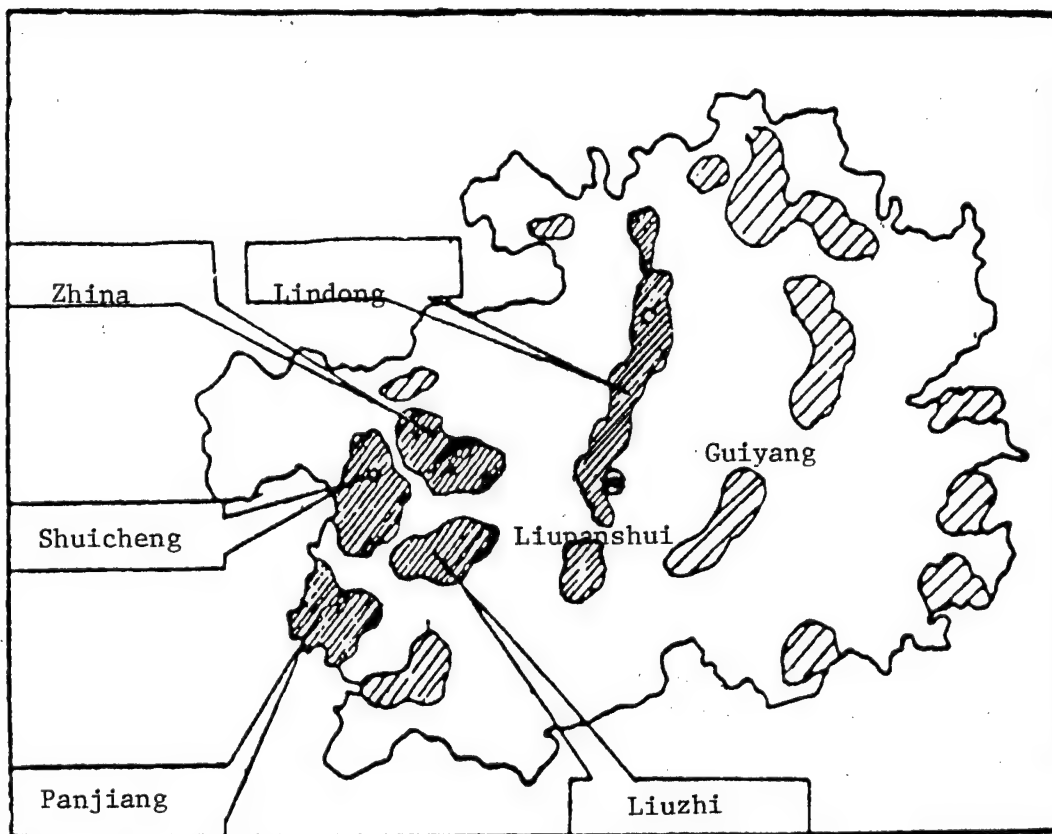


Fig. 1. The Distribution of Guizhou's Coal Resources

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## POWER NETWORK

### BRIEFS

**ZHEJIANG POWER LINK**--Hangzhou, 5 Nov (XINHUA)--The 116-kilometer Taizhou-Fenghua section of the Zhejiang Province circular power line began transmitting last weekend. This completes the line and links the Zhejiang grid with those of Jiangsu Province and Shanghai to the north. It is expected to benefit Zhejiang's ports of Ningbo and Wenzhou, designated to open wider to the outside world, and the newly-developed port of Beilin. Zhejiang has 1,200 kilometers of 220,000-volt power line, hydroelectric power stations on the Xin'an, Fuchun and Wuxi Rivers and thermal power plants at Zhenhai and Taizhou. Taizhou's four generators will have a total generating capacity of 500,000 kilowatts when fully operational in 1986. [Text] [Beijing XINHUA in English 0859 GMT 5 Nov 84 OW]

**ZHEJIANG TRANSFORMER PROJECT**--The Yueqing Xian 110KV transformer station, part of the Tai-Lin-Wen 220KV transmission and transformation project, formally began operations early yesterday [17 October] morning and began to supply power to the East China Grid. As of now, the Tai-Lin-Wen 220KV transformer and transmission project has been completely finished. [Text] [Hangzhou ZHEJIANG RIBAO in Chinese 18 Oct 84 p 1]

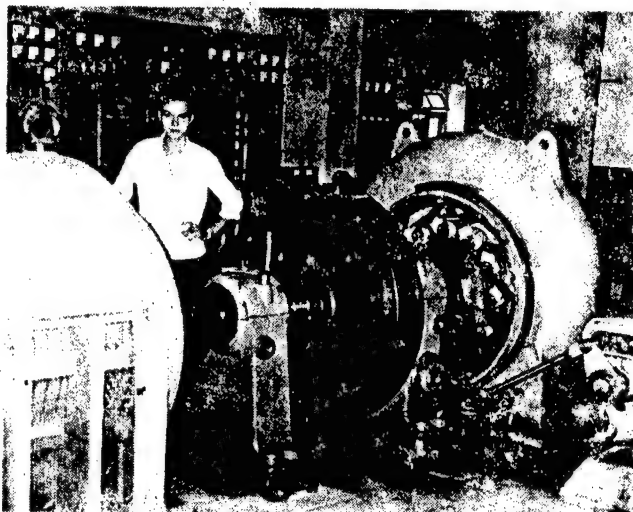
**ZHEJIANG 110KV LINE**--A portion of the key national construction project--the Taizhou Thermal Power Plant's associated Huangyan Xian 110KV transformer project--went into formal operation yesterday [19 October] morning at 11 o'clock, and now feeds power into the East China Grid. The entire project has been completed 2 weeks before the original schedule. It will relieve the acute power situation previously experienced by Huangyan Xian industry and agriculture. [Text] [Hangzhou ZHEJIANG RIBAO in Chinese 20 Oct 84 p 1]

**TIANJIN 500KV TRANSMISSION LINE**--The construction of the Fangshan-Tianjin 500,000-volt ultra-high power transmission line project a key state project and the third of its kind in north China, began on 30 October. The transmission line will transmit power from the Datong Shentou power plant in Shanxi Province to Beijing and Tianjin. The Datong-Fangshan section was completed and put into operation in the first half of 1984. The Langfang-Tianjin section, 61 km in length, is under construction. [Summary] [Tianjin City Service in Mandarin 1430 GMT 1 Nov 84 SK]

## HYDROPOWER

### SMALLER TURBINES HELP PROMOTE RURAL ELECTRIFICATION

Guangzhou NANFANG RIBAO in Chinese 12 Oct 84 p 2



[Text] By pooling resources and adopting a variety of measures, the Shuanghua District of Wuhua Xian is constructing medium- and small-scale power stations. Today, the district has 14 such hydropower stations with a total installed capacity of 2,250 kilowatts and more than 50 percent of the rural households have electricity. Shown is the Junying power station's hydraulic turbine generator built in a cooperative effort by the County and district.

CSO: 4013/31

## HYDROPOWER

### AUTOMATION OF HYDROELECTRIC STATIONS: TECHNICAL ECONOMIC EVALUATION AND DEVELOPMENT

Nanjing DIANLI XITONG ZIDONGHUA [AUTOMATION OF ELECTRIC POWER SYSTEMS] in Chinese Vol 8, No 3, May 84 pp 3-9

[Text] China has an abundant supply of water resources; its potential hydroelectric capacity is 378 million kW, and the annual production of electricity can reach 1.92 trillion kWh. The total capacity of hydroelectric power plants constructed over the past 30 years has exceeded 20 million kW.

With the development of the hydroelectric industry, rapid progress is being made in automation technology, which is essential for the operation of hydroelectric power plants. In the early 50's, our main efforts were devoted to learning Soviet technology and experience. In the late 50's, we conducted a survey of the technologies of different countries and began our own research and exploration. Today, we have developed mature technologies in single-unit control and plant integrated control; we have accumulated experience in unit regulation and automatic frequency modulation for hydroelectric stations; we have also begun research efforts in improving the efficiency of power plant operation, remote sensing of water conditions, flood forecasting, and efficient regulation of water reservoirs. In terms of automation equipment, we have passed through the evolution stages from electromagnetic relays, individual semi-conductor elements, to integrated circuits with built-in logic; we have also begun the use of microcomputers in performing research and testing to achieve automation of hydroelectric stations. The largest generator unit with automatic control has a capacity of 300,000 kW; the largest hydroelectric station with automatic control has a capacity of 1.2 million kW. The 2.715 million-kW Gezhouba hydroelectric station now has seven generator units in operation; it will be fully automated.

During the past 30 years, we have gained a great deal of experience in the automation of hydroelectric stations, but we have also wasted efforts down the wrong paths. Today, as China passes through a transitional period of economic development, it is essential to review the lessons learned from these experiences, clearly identify our future course, and follow a systematic and steady plan of development, so that the standards of safety and efficiency of our hydroelectric stations may be raised by using practical and effective methods, and by implementing the most advanced automation technologies.

## I. Major Issues in Automation of Hydroelectric Stations

Since relay protection systems have developed into a specialized field, it will not be included in the discussion here. Also, we will not discuss automation systems which have no direct relationship to power generation such as irrigation systems, fishery, and ship building technology.

### (A) Automated Operation

1. Automated Operation of Generator Unit. The starting, stopping, and changing of operating modes (idling, power generation, phase regulation, pumping water for energy storage) of the water turbine generator are all accomplished by a single pulse command according to a specified procedure. This pulse command can be issued from the central command room or activated manually, it can also be issued by an automatically or remotely controlled device. Because of the rapid starting and automated operation of the water turbine generator, operating procedures such as unit turn-on, network connection, and load switch-in can generally be completed within one or two minutes after the command is issued. This is highly desirable under emergency conditions where power outage in the system must be corrected. In addition, a hydroelectric station is often charged with the task of regulating the peak load and phase in a network, hence it undergoes frequent starting, stopping, and mode-switching operations. An automated operating system can accomplish these tasks swiftly and accurately while minimizing the probability of operating errors and reducing the amount of labor required.

2. Automated Operation of Plant Equipment. The automated operations of the compressed air system, the water drainage systems for the plant and generator unit, and the flood gates and valves are essential for ensuring the safety of the hydroelectric station.

3. Integrated Control System. Located in the central control room is an integrated control system which consists of the control operation, the warning system, and the display and adjustment of measured parameters of the entire plant. The personnel on duty in the central control room can monitor and control all the major equipment in the plant, and at the time maintain direct contact with the central control office of the network or regional offices to transmit or receive commands. Therefore, increasing the degree of automation of the plant will increase the flexibility of network load distribution and improve its safety and efficiency.

### (B) Automated Protection

The automatic protection device is activated when the non-electric parameters of the water turbine generator deviate from their normal values in order to avoid unnecessary damage to the generator unit. Generally, there are three levels of protective actions:

1. Warning. For abnormal operating conditions that do not pose immediate danger to the generator unit, such as the stator temperature exceeding the limit, rising temperature in the drive bearing or guide bearing, oil level being too

high or too low, cooling water supply being interrupted, etc., the protection system will automatically issue a warning signal or simultaneously switch in standby units. The warning signal alerts the operating personnel to closely monitor the situation and take appropriate actions to eliminate the cause of the abnormal conditions, or remove the defective unit from the network by reallocating the load.

2. Tripping and Generator Shut-Off. When the generator develops trouble that prohibits continued operation such as excessive temperature in the drive bearing or guide bearing, or oil pressure too low, the protection system will automatically trip the circuit breaker and stop generator operation.

3. Rapid Closing of Water Inlet Gate (or Valve). In the case of malfunctions such as breakage of guide vane pins, defects in the speed regulator, or burst pressure pipes, the automatic protection system not only will trip the circuit breaker and stop generator operation, but also will close the water inlet valve, emergency pressure valve or the high-speed water supply gate.

The automated protection system is essential for safe operation of the generator unit. With the increase in generator capacity and development in measurement techniques, additional requirements such as protection against vibration, wobble, displacement, and temperature may also be addressed.

#### (C) Automated Regulation

The precision, stability and quality of automated regulation of a hydroelectric station, particularly the primary station of a power supply system, have a direct impact on the quality of power supply and the safety of system operation.

In terms of power regulation, the operating personnel can regulate the power output of any generator under either active or reactive conditions. A regulator can also be installed to regulate all the generators in the plant as a single unit; regulation can also be accomplished through commands designed for automatic allocation or automatic high-efficiency operation.

The speed regulator and the field regulator are basic components of a regulation system. By measuring the frequency of the power system, a speed regulator can automatically adjust the active power output of each generator according to a prescribed rule. In the case of a frequency modulated hydroelectric plant, an overall frequency modulation device can be installed to automatically adjust the total power output of the plant.

A field regulator can reflect the bus-bar voltage of the power plant, and adjust the reactive power output of each generator according to a prescribed rule. For a hydroelectric station which may affect the stability and quality of the entire power supply system, a reactive regulator unit may be installed to regulate the reactive power output of the plant according to a prescribed rule.

#### (D) Automated Inspection and Measurement

Inspection and measurement is the key to safe operation of an electric station. Its basic function is to perform measurements, inspection, monitoring, display and recording of electric and non-electric parameters of the generator units and other major equipment. The electric parameters include frequency, a.c. and d.c. current and voltage, active and reactive power output, electric capacity and power factor. The non-electric parameters include temperature, liquid level, flow rate (or flow velocity), pressure, vibration frequency and intensity, speed of rotation, and operating mode of the generator unit.

#### (E) Automated High-Efficiency Operation

In order to meet the active and reactive load requirements and to maintain the quality of frequency and voltage of a power supply system that contains both hydroelectric and thermal-electric (including nuclear) stations, it is necessary to regulate the water reservoir, and distribute the load wisely among water turbine and gas turbine generators to minimize the coal consumption and water consumption (or minimize the cost). This is a systems engineering problem whose solution depends on many factors; in practice, it is often reduced to a local optimization problem based on the particular situation at hand.

The key question to efficient operation of a power supply system is whether water energy resources can be utilized efficiently by the hydroelectric stations. Actual experience in this country and abroad show that through efficient operation of hydroelectric stations, it is quite possible to realize a 4 percent gain in annual power output.

#### (F) Automated Measurement and Reporting of Water Conditions

The monitoring of water conditions is an essential element of the flood prevention and power generation plan. By using modern techniques to measure parameters upstream of the reservoir such as rain fall and water level, and processing the data on a computer using system discrimination and pattern recognition methods, it is possible to forecast water movement days in advance. This information is important for flood prevention and efficient allocation of resources. Flood prevention not only provides protection for the power station, more importantly, it protects the cities, farms, transportation, and people and properties downstream. One single failure in flood prevention can cost hundreds of millions of yuan in damage. Flood damage from major rivers such as Huang He or Chang Jiang may even affect the overall national economy.

Accurate flood forecast will allow the power stations to plan their operations accordingly to increase output. Depending on the particular power station, an increase of several million kWh to tens of millions of kWh can be achieved. Under normal conditions, knowledge of water conditions can be used to calculate the optimum power generation plan and to maintain maximum water drop to achieve even higher gain.

## II. Payoff in Automation of Hydroelectric Station

Carrying out the major tasks of automation in hydroelectric stations as described above will produce the following payoff.

### 1. Raising the standards of operational safety of power supply system

When trouble develops in a power supply system, the power shortage often causes a drop in frequency. By using low-frequency starting equipment, the generator units in service are quickly brought to full load, or the phase regulator can be converted to power generator, or the idling units are quickly started and automatically switched into the network to share the load. This process can be completed in 30-40 seconds, or at least 1-2 minutes, which is much faster than the starting and loading processes of gas turbine generators. If the malfunction in the system causes an oversupply of power and a rise in frequency, then one can use high-frequency cut-off or electric braking to reduce frequency. In addition, the use of automated field regulation will tend to improve system stability and prevent the network from collapsing. These automation techniques play an essential role in ensuring the safe operation of the power supply system and therefore deserve closer attention.

### 2. Ensuring the safe operation of hydroelectric stations

Under normal conditions, the automation of hydroelectric stations allows error-free operation and adjustment in a timely manner, thereby avoiding many human errors. Under abnormal and emergency conditions, it can remove the defective component from service to prevent the problem from spreading, and to minimize equipment losses. It can also issue a warning signal and display the problem area so the personnel on duty can correctly determine the cause and take appropriate actions. A power station with automated water condition monitoring capability can provide more effective flood prevention, thereby reducing the danger of flood damage to the power station and to the population living downstream.

### 3. Fully utilizing hydro energy resources to realize the economic benefits of energy conservation

The automated and efficient operation of hydroelectric stations can improve the utilization rate of hydropower resources. If through modern technology the operating efficiencies of all the existing hydroelectric stations are improved to achieve 1 percent gain in the utilization rate of hydro energy, then the annual power output will increase by 1 billion kWh, which is equivalent to 40-50 tons of standard coal. Increasing the utilization rate of hydropower by 1 percent is not difficult to achieve; therefore, it is of practical economic value to initiate a carefully planned and systematic approach to convert existing hydroelectric stations in order to achieve automated, efficient operation.



#### 4. Ensuring the quality of electric energy

As with thermal electric stations, hydroelectric stations are equipped with speed regulators and field regulators to adjust the active and reactive power distribution of the system in order to maintain the frequency and voltage within a prescribed range. But because of the relative simplicity of the production process of water turbine generators, it is easier to achieve automation and high reliability. Therefore, a number of large and medium size hydroelectric stations are equipped with active and reactive group regulation and automated frequency modulation capabilities in order to better satisfy the needs of the electric power station.

#### 5. Raising the standard of operation, improving labor conditions, and increasing the rate of production

The term "automation" is often interpreted to be "eliminating human labor." It has been suggested that since China has an abundant supply of human labor, there is no need to pursue advanced technology and automation. This is clearly a misconception. Automation not only can improve labor conditions, increase production efficiency, but also improve safety standards to meet safe production requirements. For example, scattered local control units can be replaced by integrated control in a central control room; manual reading of meters can be replaced by automatic monitoring and measurement; decisions based on empirical estimates can be replaced by load distribution based on optimization calculations; manual transfer of orders can be replaced by automated reception and execution of commands; hand copying can be replaced by automatic recording; and manual trouble shooting can be replaced by automatic diagnosis and corrective actions. These measures will greatly improve the speed, accuracy, reliability and safety of various operations and adjustments of hydroelectric stations. In addition, one can also expect to gain the following benefits:

(1) The operating personnel will be relieved from repetitive and tedious labor so they can concentrate their energy on improving operating procedures and preventing accidents.

(2) All operations will be performed according to prescribed procedures; they will not be affected by the ability, experience or physical and mental condition of the operator. Consequently, the possibility of operator error is reduced or eliminated.

(3) As a result of increased production efficiency, it is possible to reduce the number of operators to a minimum. This is of particular importance for hydroelectric stations located in remote regions, because quite often large amounts of money and materials are provided for the employees of such stations for their consumer supplies, education costs, medical expenses, living quarters, recreation facilities and transportation needs. By implementing automation and centralized inspection and repair, and adopting the methods of rotational shifts and periodic inspection tours, a large amount of savings can be realized by reducing the number of personnel. This will accelerate hydroelectric construction and produce real economic benefits.

### III. Development of Automation of China's Hydroelectric Stations

In the 50's, when the People's Republic was in its early years, the representative generator units were Fengman No. 7 and No. 8. They were controlled using single-unit electromechanical type relays; they also had mechanical speed regulators, coaxial d.c. and composite field voltage compensators, integrated central control, control panel with screens, square-shaped meters, and one-to-one signal light system. For normal synchronization, they used electronic type automatic pseudo-synchronous devices; they also had manual pseudo-synchronous devices as standby units, and used automatic self-synchronization in case of emergency. The temperatures of the generator bearings, air cooling units, and components inside the generator were measured using an expansion type thermometer; the relative temperature sensing elements could be replaced manually, and the temperatures of generator stators and bearings were monitored manually by taking periodic readings.

In the 60's, significant progress was made in automation technology for hydroelectric stations.

In the area of integrated control, the Guanting hydroelectric station began using weak current selective circuit integrated control without signal feedback screen. Toward the late 60's, the central control room of the Liujiaxia hydroelectric station began using strong current devices to provide one-to-one control.

In the area of single-unit automation, electrohydraulic speed regulators were widely used; also, automatic frequency modulators as well as active and reactive group regulators were used at the Xin'an Jiang and Yanguoxia hydroelectric stations, and silicon controlled field regulators were introduced. By the 70's, silicon controlled stationary field devices became widely used. The logic control elements evolved from electromechanical type relays to transistor components to integrated circuits. Large electric stations began using scanning detectors as multi-purpose devices for warning against excessive temperature and current, as well as for periodic recording and printing. In addition, efforts were made to explore the use of electronic computers to achieve automation of hydroelectric stations.

From the 70's to the early 80's, new progress was made in automation.

Efforts in optimum regulation of water reservoir were put into practice. For example, from 1975 to 1977, the Fuchun Jiang hydroelectric station performed off-line calculations using a digital computer for flood forecast, and increased the power output by 74.2 million kWh, which is equivalent to a saving of 29,600 tons of standard coal. Based on the results of optimum regulation at several water reservoirs, an average gain of approximately 3 percent can be achieved.

Coordinate type signal systems and industrial television systems were used at multi-generator, large scale hydroelectric stations.

Computer control has evolved from the use of minicomputers to microcomputers. A device for recording the sequence of abnormalities has been introduced. Once single-unit and integrated microprocessor control systems are implemented for actual use, the automation of hydroelectric stations will enter into a new era.

Efforts have also been initiated to test the automated and integrated regulation and control systems for cascade hydroelectric stations.

#### IV. Existing Problems and Direction of Future Efforts

The three stages of development described above showed that over 33 years, steady progress has been made in the automation of China's hydroelectric stations. However, there still exist a number of weak spots and problem areas. The biggest problem is the quality of components and equipment. The poor quality of components and equipment caused so much trouble for the operators that they simply abandoned some of the new automation equipment. The second problem is organization. Often there is no overall plan to implement new technologies; everyone participates in a random fashion, and disappears when problems develop. The result is that many new technologies are abandoned halfway without making contribution to production, and a great deal of manpower, materials and valuable time have wasted. We learned from this lesson that to take advantage of a new technology, we must concentrate our efforts and follow a systematic plan until all difficulties have been overcome. The third problem is training. One of the reasons for the failure to develop automation is that many operating and maintenance personnel cannot fully grasp some of the new technologies. Therefore, establishing a comprehensive training program is an important issue for developing and expanding automation technologies.

During the next few years, we should carefully review the status of automation of hydroelectric stations both here and abroad, and devote our efforts to strengthen the foundation of automation of hydroelectric stations in this country. We should organize the forces in the areas of research, design, manufacturing, assembly, and operation based on the guidelines of safety, reliability, energy conservation and economy. We should develop a plan and a systematic approach to solve the urgent problems at hand; and we should place equal emphasis on research and organization. The following paragraphs summarize our views on these issues.

1. The immediate goals in automation of hydroelectric stations are to improve the standard of automation and the quality of the primary and auxiliary equipment, to improve the quality and reliability of components of various converters, to improve the integrated automation system, and to increase the economic benefits and production efficiency of hydroelectric stations. To reach these goals, we should review China's current status and concentrate our efforts on research and development by establishing research agencies, hydroelectric plants, and other related organizations. The research efforts should be pursued with the objective of producing reliable, practical and immediate results.

2. A basic criterion for achieving automation of hydroelectric stations is that the primary and auxiliary generator units must be of high quality and high

reliability. Defects in the primary generator will severely affect the successful implementation of automation; hence we must first ensure that the generator is in good condition through careful manufacturing, operation and maintenance. Second, we must improve the stability and reliability of the speed regulator and field regulator. Efforts should be made to improve the existing mechanical type and electrohydraulic speed regulators; regulators with proven performance should be widely distributed; having established a good foundation, we can develop the advanced PID speed regulator and the microprocessor speed regulator. In the area of field devices, we should strive to improve the quality and reliability of the various types of silicon controlled field devices that exist today. In the future, we should develop silicon controlled devices with new regulation rules; we should intensify our efforts in the tasks of standardization and serialization, as well as in the development of microcomputer field regulators. At advanced level research organizations modern control theory should be used to study new speed regulators and field equipment.

3. Improving the reliability of the basic components of automation. Production facilities should be built and new applications should be explored for newly developed, high-quality components such as electromagnetic coils and subcurrent signal devices. A research team should also be organized to study and improve other types of automation components. We must improve the quality of those products with poor performance by improving the manufacturing technique and using high-quality materials. New components must be developed to replace those products that are intrinsically and structurally defective so as to provide a complete set of usable automation components.

4. In the area of using computers for automation of hydroelectric stations, we should continue the test projects currently in progress until they are completed and useful results are obtained. Through practical experience we can better understand the advantages of computers and promote the expanded use of computers. At present, we should concentrate our efforts on the application of computers in large-scale hydroelectric stations and in terraced hydroelectric stations. Efforts should also be devoted to study the application of microcomputers in integrated monitoring and control systems and in special-purpose equipment. In addition, we should address the problem of importing new monitoring and control technologies from abroad and the problem of applying modern control theory for automation of hydroelectric stations.

5. Intensify the research efforts in high-efficiency operation and utilization of hydroelectric stations. Many hydroelectric stations have already implemented techniques for long-term and short-term allocation of water reservoirs; significant economic benefits have been obtained as a result of conducting studies and carrying out calculations to achieve optimum utilization of seasonal electrical energy and optimum allocation of resources based on flood forecast.

In the future, additional efforts should be devoted to study the theory of optimum allocation, to simplify computational techniques, and to develop optimum allocation methods for utilizing water reservoirs based on considerations of flood prevention, shipping, and irrigation. We should also

address the problem of optimum allocation for terraced hydroelectric stations and for groups of hydroelectric stations, including the problem of efficient operation of an entire network of hydroelectric stations.

6. We should accelerate the construction of research and training facilities for the automation of hydroelectric stations, establish a complete technical intelligence network and promote technical exchanges with other nations. We should also emphasize conducting research on raw materials and basic components, improving manufacturing techniques, and increasing product quality.

7. We should suggest importing turnkey automation systems from abroad (including installation and software), and establishing research teams and related organizations to absorb the state-of-the-art technologies so as to improve the backward status of China's hydroelectric stations in the very near future. We should concentrate our efforts to solve the urgent problems at hand, and place equal emphasis on research and organization. Some of our views on these problems are presented below:

1. The goals in automation of hydroelectric stations are to improve the performance of integrated automation systems; to improve the safety and reliability of power stations and the individual hydroelectric stations; to increase the utilization efficiency and economic benefits of hydro energy; to reduce the labor intensity of operating personnel; and to increase production efficiency. To reach these goals, we must establish a plan of systematic development based on China's current conditions and the objectives of producing reliable, practical and immediate results.

2. We must consolidate our current achievements, and strive to improve the quality of basic automation components and equipment. We should develop high-quality integrated control components and equipment, and establish quality specifications for a product series. We should improve the stability and reliability of electrohydraulic speed regulators and silicon controlled field devices; we should continue to improve product quality, expand the range of product applications, and strengthen management personnel. Research must be conducted for each basic automation component used in hydroelectric stations. Improvements should be made to products which are theoretically mature but poor in performance by improving manufacturing techniques and quality of materials; products which are theoretically and structurally defective must be replaced by new components so as to make available a complete set of reliable automation components. Our goal is to achieve more than 99.5 percent reliability in terms of starting and stopping operations of generator units in a few years.

3. We should review our experience and lessons learned over the years in applying computers for automatic control of hydroelectric stations, try to solve the existing problems in hardware and software, and establish a comprehensive research program in computer technology. We should also develop a systematic plan to promote the application of computers. We should encourage all personnel to apply modern control theory in integrated automation of hydroelectric stations, so that the capabilities of computers can be fully exploited to perform the tasks of real-time information collection, safety monitoring, responding to abnormal conditions, flood forecasting, efficient



allocation of water reservoirs, efficient plant operation, and efficient operation of cascade hydroelectric stations.

Microcomputers should be used as the central core of the real-time control system. Modern microcomputers have internal storage capacity of 16 megabytes, and use virtual storage techniques; it can also accommodate various high-level languages. In general, a microcomputer can satisfy the requirements of automation of hydroelectric stations. For very high capacity hydroelectric stations, it may be necessary to use mid-size or mini-computers.

4. Intensify research efforts in integrated automation of hydroelectric stations. The measurement and reporting of water conditions, allocation of water reservoirs (including flood prevention, irrigation, shipping, logging, fishery, and power generation), integrated control of cascade hydroelectric stations, and optimum control of power system operation are problems that should be studied using systems engineering methods. In addition, efforts should also be devoted to the study of various subsystems such as the water condition remote sensing, forecasting, and treatment system, the water reservoir allocation and management system, the optimum allocation of cascade hydroelectric stations, and the integrated automation of hydropower stations in order to maximize economic benefits and accumulate valuable practical experience.

5. Develop a comprehensive plan of technical exchange and training in the area of integrated automation of hydroelectric stations; establish an effective technical intelligence network and prepare technical illustrations, manuals, and standards for new automation equipment.

6. Accelerate the work in experimental research, certification, and construction of training bases for integrated automation of China's hydroelectric stations. Because of the importance of these activities in raising the standards of automation, we should provide advanced research facilities and assign competent technical personnel to carry out the tasks of production, organization of research projects, certification of automation equipment and establishing training programs for new technologies.

In this article we have briefly described the history of automation of China's hydroelectric stations over the past 33 years and presented some of our views on future efforts. It is our hope that this will stimulate some discussions in the community; in particular, we welcome any constructive opinions or criticisms to help choose the correct course for the future. We also encourage organizing technical conferences to support the activities of research, design, manufacturing and operation of automation in order to meet the demands of the socialist four modernizations and to make contributions to the future development of automation of China's hydroelectric stations.

## HYDROPOWER

### BRIEFS

GIANT STATIONS IN QINGHAI, YUNNAN--Two great hydroelectric power stations second only to Gezhouba are to be built in northwest and southwest China. One, the Liujiaxia hydropower station, is located within the border of Qinghai Province. It has an installed capacity of 2 million kilowatts, 720,000 kilowatts greater in capacity than the Longyangxia station now under construction. The other, the Manwan hydropower station, is located on the Lancang Jiang in western Yunnan Province. It has an installed capacity of 1.5 million kilowatts. The preliminary plans for both hydropower stations were reviewed by concerned state organs in Kunming and Xining in mid and late September [1984]. [Text] [Beijing GONGREN RIBAO in Chinese 12 Oct 84 p 1]

POWER SUPPLY FOR LUBUGE--The power transmission line from the Dazhai Power Plant to the Lubuge Hydroelectric Power Station has been boosted from 35 kilowatts to 110 kilowatts and the new Gangshang transformer station has been completed. After debugging and careful inspection by the involved units, the system began to supply power on 25 September. Operations were normal, and the problem in supplying the Lubuge hydropower project with a steady flow of electricity has now been resolved. Construction can now proceed more rapidly. [Text] [Kunming YUNNAN RIBAO in Chinese 15 Oct 84 p 2]

CSO: 4013/41

## THERMAL POWER

### FIRST STAGE OF JINZHOU POWER PLANT CONSTRUCTION NOW COMPLETED

Shenyang LIAONING RIBAO in Chinese 17 Oct 84 p 1

[Text] The first stage of construction on the Jinzhou thermal power plant, a key national construction project, has now been completed and its three large 200,000-kilowatt generators are in full operation feeding power into the grid. The official ribbon-cutting ceremony was held on 16 October.

The Jinzhou power plant is Liaoning's second big thermal power plant. After more than 5 years of construction--ground was broken in June 1979--some 720,000 cubic meters of main structure have been completed plus a 210-meter-high stack, three cooling towers, and a 32-meter-high ash dump retaining wall. Associated work includes a water circulatory system, a coal conveying system, and power and water supply systems. The three steam turbine generators of the completed first stage can generate more than 14 million kilowatt-hours of electricity a day, one-seventh of the total daily provincial power consumption, and will have a major impact on easing the power shortage in the province and promoting the economy in both cities and the countryside.

First-stage construction of the Jinzhou power plant was handled by the East China Power Company No. 3. The rapid speed of construction, the high quality, and the low cost are without equal in the nation for projects of comparable size. Work on installing the No. 2 generator last year was completed in 9 months' less time than the No. 1 generator, and this year the No. 3 generator was installed in 4 months' less time than the No. 2 generator. The level of excellence in construction quality rates an 83.9, 3.9 percent higher than the state standard. The cost of construction was 5.05 percent lower than that of the state plan.

CSO: 4013/42



## THERMAL POWER

### DEVELOPMENT OF DATONG COAL SPURS POWER PLANT, RAILROAD CONSTRUCTION

Taiyuan SHANXI RIBAO in Chinese 21 Sep 84 p 1

[Text] The state is planning seven major construction projects in Datong centered around the development of the Datong coal field, coal transportation, and coal use. These include the Datong No 2 Power Plant, the Datong Coal Region (four mines, new construction at the Yanzi Shan mine, and expansion of the Xianhuaguan mine), the Datong-to-Fangshan 500KV ultra-high-tension power line, the electrification of the Feng-Sha section of the Jing-Bao railroad, the Da-Qin heavy-duty railroad, the electrification of the Bei-Tong-Pu-Fu line, and the electrification of the Datong-to-Baotou section of the Jing-Bao railroad.

The Datong No 2 Power Plant is a large-scale pit-mouth plant with a design installed capacity of 1.4 million kilowatts. The second phase of the project involves the installation of six 200,000-kilowatt generators, the first of which began generating electricity in June 1984. The 500KV ultra-high-tension power transmission line, now open, is the largest electric power artery in the North China region, and will feed a strong current to the Beijing-Tianjin-Tangshan area. Work on other projects has also begun. After the Datong coal region projects go into production, some 10,000,000 tons of raw coal could be mined a year, one-third as much as the current annual output of the [entire] Datong Coal Mining Bureau. After work begins on the Da-Qin and four other railroad projects, the capacity of the Datong hub will increase to more than 160 million tons, four times the current load capacity.

CSO: 4013/29

## THERMAL POWER

### BRIEFS

BANSHAN UPDATE--Following a 72-hour test run, the No 4 generator of the Banshan Power Plant--a major engineering project for Zhejiang Province--was officially turned over for operations on 18 September and has been providing power for peak load [requirements]. This generator, with an installed capacity of 150,000 kilowatts, constitutes a major energy-saving project in Zhejiang. Compared with Hangzhou's previous consumption of coal for power production, some 60,000 tons of raw coal can now be saved annually. [Text] [Hangzhou ZHEJIANG RIBAO in Chinese 19 Sep 84 p 1]

YONG'AN UPDATE--At 9:30 pm yesterday [20 Sep 84], following a test run of 72 consecutive hours, the first big 100,000-kilowatt steam turbine generator of the third-stage expansion project of the Yong'an thermal power plant--a major construction project in Fujian Province--went into full, steady production upon the completion of debugging and inspection. The third stage expansion project of the Yong'an thermal power plant calls for the installation of two 100,000-kilowatt water-cooled, high-temperature, high-pressure generating units. After the entire project has been completed, the power plant will have been expanded from its present installed capacity of 150,000 kilowatts to 350,000 kilowatts. Work is to begin on the second unit soon. Since the project's official ground-breaking in July 1981, with attention given by the Ministry of Water Resources and Electric Power, the provincial government, and concerned organs, and with help from construction units, the provincial First Construction Company, the provincial Electric Power Construction Company, and the Third Engineering Office of the provincial highway bureau, the progress of construction has been rapid. Only the short period of 14 months was required to install the first generator by the provincial Electric Power Construction Company. [Text] [Fuzhou FUJIAN RIBAO in Chinese 21 Sep 84 p 1]

NEW GENERATOR FOR NORTHEAST--Harbin, 30 Sep (XINHUA)--A new 200,000-kilowatt coal-fired generating unit has gone into operation at the Hulan Ergi No 2 power plant in Heilongjiang Province. It is the third and final generating unit in a 420 million yuan project started in July 1978 to add a total generating capacity of 600,000 kilowatts to the northeast power grid. The first two generating units at the power plant were completed in February 1982, and September of last year. A 220,000-volt high-tension power transmission line, 341 kilometers long, from Hulan Ergi via Daqing oilfield to Harbin, went into operation in mid-August of this year. [Text] [Beijing XINHUA in English 0824 GMT 30 Sep 84 OW]

JINZHOU UPDATE--A 200,000-kilowatt coal-fired generator, the third at the Jinzhou power plant in Liaoning Province, started to feed the northeast China power grid today. The unit's operation marks the completion of the first stage of construction at the plant, which will have a full capacity of 1.2 million kilowatts. Another three generators will be installed during the second stage, which will start soon. Work on the plant began in June 1979. It will ease a shortage of electricity in northeast China. In 1983, Liaoning Province alone lacked electricity equivalent to the annual output of a 1.5 million-kilowatt power plant. [Text] [Beijing XINHUA in English 1632 GMT 16 Oct 84 OW]

SICHUAN HEAT AND POWER PLANT--Work on the nation's first new heat and power plant at the state-operated Wuzhou Chemical Industry Machinery Corporation recently got under way. The plant will have an installed capacity of 80,000 kilowatts. As approved by the State Planning Commission and the Commission of Science, Technology, and Industry for National Defense, this heat and power project will have two 40,000-kilowatt electric generators. Yearly extra output will be 260,000,000 kilowatt-hours, which is equal to a savings of 100,000 tons of standard coal a year. The facility should be completed and join the grid in 1987. After lengthy preparations, the Wuzhou Chemical Industrial Machinery Corporation, along with the Second Design Institute of the Ministry of Machine Buildings and other units responsible for the work, finished the feasibility studies, the plans and designs for the construction projects, and much other work involved in the early-stage preparatory work, and have already broken ground on the project. After the project has been completed, it will play a vital role in easing the power shortages now being experienced by parts of Sichuan. [Text] [Chengdu SICHUAN RIBAO in Chinese 13 Oct 84 p 1]

CSO: 4013/37

COAL

HEBEI MINES BRING SEVERE FLOODING UNDER CONTROL

OW081122 Beijing XINHUA in English 0747 GMT 8 Nov 84

[Text] Beijing, 8 Nov (XINHUA)--Severe underground flooding has been brought under control in two Hebei Province coal mines, according to the Ministry of Coal Industry.

Meanwhile, production has been restarted in three nearby threatened mines, not far from the north China city of Tangshan.

The Fangezhuang mine, capable of producing 3 million tons a year, was submerged within 21 hours on 2 June. The neighboring Lujiatuo mine was also inundated 3 days later, and three other mines were threatened.

Underground water poured into the shafts at an extremely high rate of 35,000 cubic meters per hour, affecting a total of 20 square kilometers, the ministry said.

In addition to local miners, more than 1,000 rescue workers from government departments and army units rushed to the scene to counter the disaster.

Twenty deep-well pumps were installed, and drained 48 million cubic meters of water. More than 15,600 tons of cement and large quantities of sand and stones were also used to dam the flow, while 37 retaining walls were built in the pits.

An investigation of the leaks causing underground flooding has in the main been completed in the Fangezhuang mine while pumps are continuing to drain water from the Lujiatuo mine.

Earth satellites and aerial remote metering provided further data to help counter the flooding.

CSO: 4010/23

## COAL

### 'STRONG' FOREIGN INTEREST COULD HELP REVITALIZE OLD MINES

HK180350 Beijing CHINA DAILY in English 18 Oct 84 p 1

[By staff reporter Zhu Ling]

[Text] China plans to spend 4.3 billion yuan (\$2 billion) in the next 6 years to bring its older coal mines up to date, according to an official of the Ministry of Coal Industry.

The program is aimed at enabling 554 ministry-run mines set up before 1980 to produce 400 million tons of coal annually by 1990—10 years ahead of schedule.

This year, older mines are expected to turn out 360 million tons of coal, more than half the country's output, Wang Huanwen, deputy director of the ministry's production department, told CHINA DAILY yesterday.

China aims to mine 730 million tons of coal this year, 15 million more than last year. It ranks third in the world in coal production after the Soviet Union and the United States.

Coal is China's primary energy source and the country hopes to increase coal output by 30 to 40 million tons a year. Annual output should reach 1.2 billion tons by the turn of the century.

The older mines are mainly located in Shanxi, Hebei, Henan provinces and northeast China. The country now has a total of 41,000 coal mines.

A recent survey by the ministry shows that 70 percent of older coal mines still have rich reserves after years of mining. But most are badly equipped and use outdated techniques, Wang said.

"Some mines are nearly 100 years old and they are as deep as 1,000 meters. Inadequate equipment and machinery are hindering the tapping of their potential," he said.

The renovation plan calls for mechanization to reach 70 percent by 1990, compared with 42 percent now. Most work is currently done by hand.

The ministry is seeking international cooperation in obtaining equipment and management is being reformed.

"We are anxious to introduce advanced management techniques from abroad. We will use computers for production and safety monitoring and we will import equipment and machinery to improve our ventilation, drainage, power supplies and coal lifting processes," the deputy director said.

Wang disclosed that the ministry would cooperate with a British company to update a 100-year-old coal mine in Tangshan, Hebei Province. A French firm is also preparing to help modernize Pingdingshan Coal Mine in Henan Province, which opened up in 1958.

Many companies in Japan, Poland, and Federal Germany have also shown strong interest in helping the ministry's renovation drive, Wang said.

CSO: 4010/22

COAL

#### IMPORTED TECHNOLOGY AIDS DATONG COAL PRODUCTION

OW141207 Beijing XINHUA in English 1129 GMT 14 Nov 84

[Text] Taiyuan, 14 Nov (XINHUA)--Technical transformation in Datong, China's leading coal center in Shanxi Province, in the last decade has greatly boosted the mines' production, according to the Datong coal mining administration.

Coal output this year is expected to reach 28 million tons, 800,000 tons more than last year, and double the output in 1973, the year before overall upgrading began.

Datong is one of China's oldest coal mining areas. The mining administration has, since 1974, put into operation 32 sets of equipment for fully-mechanized coal faces. Included are 22 sets imported from Japan, Britain and the Federal Republic of Germany. Now, 70 percent of coal cutting in the mines is done by machines.

Last year the administration handed over more than 400 million yuan in taxes and profits to the state, 2.5 times as much as the state investment in upgrading the mines between 1974 and 1983.

A train-load of 1,400 tons of coal now leaves Datong every 25 minutes for other parts of China.

The administration decided to further update its mines to turn out more than 30 million tons next year.

CSO: 4010/23

## COAL

### COAL MINISTRY DRAFTS PLAN TO RENOVATE, EXPAND OLD MINES

Beijing RENMIN RIBAO in Chinese 15 Oct 84 p 2

[Summary] Beijing, 14 October--The Ministry of Coal Industry has recently drafted a plan that would focus on the renovation and expansion of older, working mines, along with the vigorous construction of new shafts. After an exhaustive study of more than 550 currently producing mines, it was determined that 70 percent of the shafts still contained sizable reserves and had a considerable service life left in them. The ministry's new plan stipulates that within the time frame of the Seventh Five-Year Plan, the renovation and expansion of these mines will occupy one-third of all construction. Following renovation and expansion of the nation's unified distribution mines, output is expected to grow by more than 32 million tons in the period of the Sixth Five-Year Plan, and by more than 50 million tons during the Seventh Five-Year Plan. Taking into account the loss of production as the older mines are worked out, this still represents a net gain of some 35 million tons. In addition, during the Seventh Five-Year Plan, production from these expanded mines will top 43 million tons while new production is expected to exceed 50 million tons. In its plan, the Ministry of Coal Industry has stressed the following measures:

- 1) The vigorous pursuit of mechanized extraction, the target being 70 percent mechanization by 1990;
- 2) The vigorous application of new technology, equipment, and techniques;
- 3) The full-scale adoption of the investment contract economic responsibility system and the contract bidding system.

CSO: 4013/29



COAL

# FOREIGN EQUIPMENT REVITALIZES 'WORKED-OUT' FUSHUN MINE

OW091117 Beijing XINHUA in English 1034 GMT 9 Oct 84

[Text] Shenyang, 9 Oct (XINHUA)--Foreign heavy-duty trucks, excavators, and power equipment have been moved to Fushun to start a 240-million yuan technical transformation scheme aimed at revitalizing the 70-year-old opencast coal mine in western Fushun.

Drilling, crushing, dressing, and other advanced conveying equipment, all imported from abroad, will arrive soon.

The Chinese Government decided to transform the old mine in March of this year and entrusted the U.S. Fluor Engineers Inc. with the designing for stabilizing the side walls and improving the conveying, crushing, and lifting systems.

According to mine officials, this is China's first attempt to upgrade the old mines with foreign technology and equipment. More of such projects are expected if the current scheme is proved successful.

The western Fushun opencast mine was opened 70 years ago. Its peak annual output reached 3.6 million tons. Over the past 35 years since the founding of new China, the mine has produced 120 million tons. It is of vital importance for the heavy industrial base of northeast China.

But as the mining went deeper and deeper, the side walls became less firm and the mining equipment needed replacement and the conveying capacity fell short of demand. Annual output dropped to about 2.5 million tons.

The current scheme, scheduled for completion in 1988, is expected to raise the mine's annual output to 5 million tons and the annual output of oil shale to 10 million tons. It involves a major shift from overall mining to divisional mining, from rail transportation to a combined transport system by rails, trucks and conveyors.

The mine has workable coal reserves of 109 million tons, enough to be mined for another 20 years at an annual rate of 5 million tons, the mine officials said.

CSO: 4010/9

## COAL

### SHANXI COAL OUTPUT OVER PAST 35 YEARS REVIEWED

OW251254 Beijing XINHUA in English 1227 GMT 25 Sep 84

[Text] Taiyuan, 25 Sep (XINHUA)--China's leading coal producer, Shanxi Province, is now turning out 59 times as much coal a year as 35 years ago, according to the provincial coal department.

Between 1949 and 1978, the province's coal output increased at an average annual rate of 3.29 million tons. The annual coal output broke the 100-million-ton mark for the first time in 1979, and in 1983 its annual output reached 159 million tons, averaging an annual increase of 12 million tons in the last 5 years.

By contrast, 35 years ago it only produced some 2.7 million tons a year.

Now a coal production drive is sweeping across the province. The seven major state-run mines and the more than 3,000 smaller coal mines and pits run by the local authorities are keeping a steady supply to 26 provinces and meeting the needs of China's export to Britain, France, the Netherlands, Italy, Japan and other countries.

The past 35 years have seen a huge amount of investment pumped into coal production in the province, especially in recent years as the state has given priority to energy development. The annual investment in 1983 came to 456 million yuan, 47 percent more than in 1982. This year's investment is expected to reach 850 million yuan, 54.5 percent more than in the preceding year.

Most of the investment is used to construct new mines or expand or transform the old ones. Over the past three decades, the province appropriated funds to build or expand 108 coal mines with a total designed capacity of 88.56 million tons. By the end of 1983, 84 mines had been completed, adding a production capacity of 50 million tons. Twenty-four mines are now under construction; they include five "super mines," each with an annual production capacity of 3 million tons. The completion of the new mines will add another 38.5 million tons.

The provincial coal department said that in the future the province will start a number of new projects every year, and every year will see the operation of new mines.

By the end of this century, the department said, it is planned that the province's annual coal output will reach 360 million to 400 million tons, accounting for about one-third of the country's total as against one-fifth at present. According to this development program, the average annual increase will be maintained at over 15 million tons in the next decade.

In addition, the state has invested in 19 coal dressing plants with a combined production capacity of 26.4 million tons, 14 of which have been completed.

Through technical innovations, most of the mining is now done by machines. Seventy-nine imported and domestically made coal-cutting combines have been installed in the province.

The vigorous coal production has stimulated railway and road construction and the development of chemicals and power industries.

Now the province has seven trunk railway lines totalling 2,115 kilometers. The volume of transport has increased more than seven times compared with the early post-liberation days in the 1950's. Four new rail lines and electrification and double-tracking projects of the old lines are being pursued to smooth out bottlenecks in getting the coal out of the province.

Four new trunk roads will be completed next year to connect with Henan, Hebei, and Shandong provinces. This will increase the road handling capacity from the present 10 million tons to 23 million tons.

Power plants at pitheads have sprung up. Up to the present, the total power-generating capacity has reached 2.7 million kilowatts, 68 times the figure in 1949. Last year, the province supplied Beijing, Tianjin, and Tangshan with 1.38 billion kWh of electricity.

The chemical industry, with coal as the raw material, has developed rapidly. There are 86 chemical fertilizer plants in operation, producing 600,000 tons of synthetic ammonia a year. Another big chemical fertilizer plant is under construction. When it is completed in 1986, it will produce 900,000 tons of phosphorus nitrate a year, and will be China's largest.

Faster development in the communications, power industry, chemicals, metallurgy and machine building industries is expected with the further development of the province's coal industry, the coal department said.

CSO: 4010/11

COAL

# YIMINHE PUTS SECOND BIG STRIP MINE INTO OPERATION

OW101425 Beijing XINHUA in English 1300 GMT 10 Oct 84

[Text] Hohhot, 10 Oct (XINHUA)--A new opencast coal mine at the Yiminhe mining area in Inner Mongolia began production today.

This is the second such coal mine in operation in this region since the beginning of this year.

The first one, the Nanlutian [south opencast] mine in the Huolinhe mining area began production on 1 September. It has an annual production capacity of 3 million tons of lignite.

Designed by China itself, the first cutting zone of the No 1 opencast mine took only 1 year to complete. It will put out 1 million tons of coal a year. The transportation system was imported from abroad.

Construction of the other cutting zones of the mine still continues. The whole mine, with an annual production capacity of 5 million tons, is scheduled to completion by the end of 1986.

Located in the Hulun Buir League in northeastern Inner Mongolia, the Yiminhe mining area has an estimated coal reserve of 5 billion tons, 2.2 billion tons of which are suitable for open mining. The whole area is expected to put out 55 million tons annually by the year 2000.

According to geologists, an estimated 30 billion tons of coal have been verified in the Hulun Buir League where many minority ethnical groups live. Development of coal resources will help provide job opportunities and stimulate the development of local economy. It will also help alleviate energy shortage in northeast China.

CSO: 4010/9

## COAL

### BRIEFS

NEW RESERVES FOUND IN OLD MINES--Shenyang, 26 Sep (XINHUA)--An estimated 700 million tons of new reserves have been found in Fuxin, an 87-year-old coal mining area in Liaoning Province. Sunk in 1897 in central Liaoning, the Fuxin mine was believed to be exhausted. Geologists began new studies of the area in 1972. A new coal field with reserves of 210 million tons was first found in 1974. More were found in the following years. Up to now, more than 700 million tons have been verified. [Text] [Beijing XINHUA in English 0308 GMT 26 Sep 84 OW]

SHUANGYASHAN DRESSING PLANT--Following technical upgrading, the coal washing plant of Heilongjiang's Shuangyashan coal mining bureau has had its old equipment replaced, giving it a capacity of 2.1 million tons a year. For a long time, the annual capacity of this plant has hovered at around 1.1 million tons. Following the Third Plenum of the 11th Party Congress, the plant undertook a study and then formulated a plan for technical transformation covering the last 3 years. As of now, 10 of the 11 projects have been completed with all economic and technical targets being met. Technical transformation brought obvious economic benefit to the plant. In June of last year, they changed the original plan calling for lump coal elimination to lump coal sorting, boosting the washing rate from the old 84 percent to 94.3 percent, and the gangue coal content fell to 1 percent. [Excerpts] [Beijing RENMIN RIBAO in Chinese 22 Oct 84 p 2]

NEW SHANXI MINES--Taiyuan, 25 Oct (XINHUA)--Construction has begun on another large mine designed to produce 1.8 million tons of coal a year in Shanxi Province, China's leading coal producer. The Wangping mine in Huaiaren County--a national key construction project--will be put into operation in 1988. Twenty-five coal pits are now being built in Shanxi. They will have a combined annual production capacity of 44.8 million tons, according to the provincial department of coal industry. Shanxi produced 159 million tons of coal last year, accounting for 22.4 percent of the nation's output. Since the beginning of this year, seven new coal pits--designed to produce 7.44 million tons--have been put into production. [Text] [Beijing XINHUA in English 0818 GMT 25 Oct 84 OW]

CSO: 4010/18

## OIL AND GAS

### CONDITIONS SAID RIPE FOR RAPID DEVELOPMENT OF NORTHWEST OIL AND GAS

OW060759 Beijing XINHUA in English 0647 GMT 6 Nov 84

[Text] Beijing, 6 Nov (XINHUA)--A well producing 200,000 cubic meters of natural gas daily has been sunk in China's transregional Shaanxi-Gansu-Ningxia area, according to the Chinese Ministry of Petroleum Industry.

This is one of several discoveries in the area which contains a large overthrust belt, a geological formation which indicates good oil and gas entrapping conditions.

Oil has been reported in drilling exploratory wells north of Yanan, Shaanxi Province.

The oil zone in the transregional area covers 320,000 square kilometers, according to Zhai Guangming, a top Chinese petroleum geologist.

Good oil and gas showings have been reported in an oil-and-gas-bearing sedimentary basin at the bend of the [Huang He] in the Inner Mongolia Autonomous Region and Ningxia and the sediments have proved to be very thick, geologists said.

Oil reserves have been verified in three oil zones now being developed in Inner Mongolia.

To date, very little exploration has been conducted in the transregional area and conditions are ripe for faster development, a spokesman for the Petroleum Ministry said.

Exploration and development of China's major oil zones in the eastern part of the country will continue according to plan, the spokesman said, but efforts will also be made to accelerate development of the Shaanxi-Gansu-Ningxia area.

CSO: 4010/23

## OIL AND GAS

### LARGE OIL RESERVES FOUND IN TARIM BASIN

OW250920 Beijing XINHUA in English 0817 GMT 25 Sep 84

[Text] Urumqi, 25 Sep (XINHUA)--Geologists have discovered new gas-associated oil reserves estimated at 10 billion tons in the Tarim Basin in Xinjiang, northwest China.

A new well drilled in the basin produced about 340 tons of crude oil and 200 cubic meters of gas a day, the geologists said.

Surveys located more than 170 oil-bearing structures, about 100 oil and gas indications and two medium-sized oil and gas fields in the 560,000-square kilometer area, according to a recent meeting called to assess the basin's petroleum prospects.

One oil field developed in 1966 in the Tarim Basin now pumps out about 150,000 tons of crude oil a year.

CSO: 4013/11

## OIL AND GAS

### XINJIANG CLAIMS BIG SUCCESS IN OIL PROSPECTING

HK081215 Urumqi Xinjiang Regional Service in Mandarin 1300 GMT 7 Oct 84

[Text] Since the 3d Plenary Session of the 11th CPC Central Committee, our region has achieved remarkable success in the prospecting of oil reserves. Figures provided by the Xinjiang Oil Administration Bureau show that from 1979 to the first half of this year, the region has discovered a total oil reserve of about 700 million tons, in other words, 1.7 times the total amount of oil reserves discovered in the 28 years prior to 1978.

The prospecting of oil reserves is the foundation of the whole oil industry. Since the 3d Plenary Session of the 11th CPC Central Committee, in order to discover more oil reserves in a short time and to provide a reliable scientific basis for the extensive development of our oil industry, with the vigorous support of the state, our region has increased its investment in the prospecting of oil reserves, built up its strength, and imported advanced technologies from abroad. Now the region has an oil prospecting team with more than 30,000 workers. With all the necessary branches, the team is well-equipped and technologically advanced. In addition to this team, more than 20 prospecting teams sent by the third headquarters of the Geophysical Prospecting Bureau under the Ministry of Petroleum Industry and the Northeast Oil Geology Bureau under the Ministry of Geology and Mineral Resources are also prospecting for oil in Xinjiang.

Compared with the past, oil prospecting in Xinjiang has rather rapidly developed as far as comprehensiveness, technical progress, the building of contingents of prospectors, and economic results are concerned.

In addition to discovering huge reserves of oil, the region has effected three breakthroughs in the theories concerned with oil prospecting:

First, it has acquired a new understanding of the fault zone stretching from Karamay to Urho. It has arrived at the conclusion that it is an extensive fault zone, 250 km in length and 20 km in breadth, composed of shale. Within this zone, oil can be found in four locations. Thus, it has found more prospective fields.



Second, it has effected breakthroughs in ascertaining the oil-bearing strata and discovered that the Permian system and the Carboniferous system are generally oil-bearing and that igneous rock brews oil [as heard].

Third, it has discovered oil pools of industrial value in the eastern Junggar Basin, thus discovering more prospective areas.

CSO: 4013/9

## OIL AND GAS

### PLA ASSIGNS THOUSANDS OF PERSONNEL TO SHENGLI

OW110440 Beijing XINHUA Domestic Service in Chinese 1545 GMT 8 Oct 84

[Excerpts] Beijing, 8 Oct (XINHUA)--In compliance with the instruction of the Party Central Committee and the Central Military Commission, Jinan Military Region has decided to send three divisions and two regiments of troops to support construction of the Shengli Oil Field. The first batch of nearly 10,000 commanders and fighters, who had arrived at the oil field construction site, held an oath-taking rally on 8 October, and started construction.

Since the 3d Plenary Session of the 11th Central Committee, Shengli Oil Field has scored remarkable achievements in petroleum prospecting, drilling footage, and crude oil production, indicating its bright prospects for development. Since the beginning of this year, Comrade Hu Yaobang and other central leaders have successively inspected the area and called for "building the oil field into a second Daqing, in order to greet the 40th founding anniversary of the country." Leaders of the Central Military Commission have also instructed the Jinan Military Region to actively support construction at the Shengli Oil Field. To meet the needs of oil field construction, the Jinan Military Region has taken the responsibility to build two highways, two large reservoirs to ensure the recharge of the highly productive oil field, as well as to supply drinking water for workers, and a communication line from the oil field's command post to its new production areas.

While addressing the oath-taking rally, a leader of the Jinan Military Region urged all commanders and fighters participating in oil field construction to firmly foster the ideas of working for the benefits of the people, and making contributions to the four modernizations, as well as to make efforts to accelerate the pace of the construction they are supporting.

CSO: 4013/9

## OIL AND GAS

### LIAOHE CONTINUES TO INCREASE CRUDE OUTPUT

Shenyang LIAONING RIBAO in Chinese 7 Aug 84 p 1

[Report by Zhao Yonghe [6392 3057 3109] and Wang Houti [3769 0624 7555]:  
"Liaohe Oilfield Strives To Become Third Major Oilfield; Crude Oil Output  
in the 7 Previous Months Increased by 25 Percent Over the Same Period Last  
year; Increase in Oil Reserves Equivalent to Last Year's Total"]

[Text] A new situation has appeared in the production and construction of China's fourth largest oilfield--the Liaohe Oilfield. In an area of 12,400 square kilometers, derricks stand in great numbers, drilling rigs roar and more than 70,000 petroleum staff and workers encourage genuine enthusiasm and fight bravely for oil. In early August the daily production of crude oil reached 21,000 metric tons, setting a new record. In the 7 previous months, crude oil output increased by 25 percent over the same period last year and the increased geological reserves of oil are equivalent to the total increase in geological reserves in the whole of last year. Today, with the exception of close to 100 favorable areas for exploitation as prospected in the Liaohe Basin, it has been discovered through comprehensive geological study that small sedimentary basins in Fuxin, Zhangwu, and Beipiao in Liaohe as well as Kailu and Chifeng in Nei Mongol can provide new areas for future prospecting. The Liaohe Oilfield has shown vast vistas to the people.

The new situation in production and construction of the Liaohe Oilfield has been initiated under arduous conditions. After more than 10 years of prospecting, underground reserves that are easily found in the Liaohe Basin have essentially been discovered. Since the beginning of this year, staff and workers of the oilfield have further liberated their minds, focused on increasing the geological reserves of oil and crude oil production, stressed scientific and technical progress, tackled all key scientific and technical problems and completed 92 technical projects for popularization. They have assimilated the most advanced prospecting techniques from abroad, particularly the oil prospecting method in earthquake stratigraphy, thoroughly investigated the subsidence in Damintun, promptly ascertained 11 ancient submerged mountains, successfully discovered the industrial oil gas flow of hidden oil deposits and opened two oil wells in the granite stratum each exceeding 1,000 metric tons. This is seldom seen in the history of oil search in China.

The Liaohe Oilfield vigorously implements the principle put forward by leading comrades of the Party Central Committee that we must have "less investment, more output" in oilfield construction, stressed the work of comprehensive readjustment and tapping the potential of old oil areas, checked the data of 2,200 old wells and obtained almost 100,000,000 metric tons in geological reserves. At the same time, it has adopted measures to increase the output of old wells which are made productive once more.

Recently, when General Secretary Hu Yaobang listened to the report of the leaders of the oilfield and when Premier Zhao Ziyang inspected the Liaohe Oilfield, both men encouraged everyone to strive to become China's third major oilfield which strongly inspired the broad masses of staff and workers. They repeatedly made geological verification, set up measures to increase production and formulated development plans in striving to become "Number 3 in oil" at an early date.

9586

CSO: 4013/217

## OIL AND GAS

### DEVELOPMENT OF OFFSHORE SEISMIC PROSPECTING OUTLINED

Baodong SHIYOU DIQIUWULI KANTAN [OIL GEOPHYSICAL PROSPECTING] in Chinese No 3, 15 Jun 84 pp 193-199

[Article by Xie Jianming [6200 0494 7686]]

[Excerpts] Abstract. Marine Seismic prospecting began in the west in the 1930's. It went through the same steps in development that land seismic prospecting had, but at a faster pace due to better efficiency, lower cost, the results being available quicker. Today, marine techniques have far outstripped those for land, as for instance 3-D and high-resolution prospecting techniques are widely employed.

Marine seismic prospecting got its start in China in the 1960's, and in 20-odd years we have just about recapitulated the 40 years of development work in the west. With 1982's work our digital mileage was 330,000 km. Looking at the entire ocean area, this is still too low a level of prospecting. Thus we must speed up marine seismic prospecting, adopt advanced foreign techniques, to find new marine oil and gas resources at an earlier date.

China began its search for offshore oil in 1959, drilling the first well in the shallow waters of the Yinggehai. Seismic prospecting began in the shallow waters off southern Hainan Island in 1962. In 1964 it moved to the Bohai. Since 1964 seismic exploration work has continued to develop in the southern Yellow Sea, the Bac Bo Gulf, the northern Yellow Sea, the mouth of the Zhu Jiang and in the East China Sea.

The development of marine seismic technology over the last 20 years in China just about recapitulated the 40-odd years of the history of development in rest of the world. Before digitalization, the quality of the work done in the southern Yellow Sea, the Bac Bo Gulf and in the Bohai was fairly low, only able to suggest certain conditions of regional structural geology and of the structure of shallow strata. Beginning in the 1970's digitalization took over very quickly. In the 10 years that followed, ultra high coverage digital profiles were completed for all the areas named above, with a total of 330,000

square kilometers completed by 1982 (including the 160,000 square kilometers completed with foreign cooperation since 1979). With the exception of the entire Bohai and the Bac Bo Gulf and areas of the Yinggehai which have already begun detailed seismic mapping and analysis, reconnaissance of the rest of the vast ocean has just been completed. So, speaking with the entire ocean territory in mind, the level of marine seismic work is still low. To compare Chinese unit area of seismic profile mileage with the unit area of the rest of the world, China's is about one half.

China has 1.3 million square kilometers of continental shelf and there is much work to be done in this vast ocean realm. Based on experience of the last few years, we must accomplish over 100,000 kilometers of seismic profile mileage in the present period.

It should be stressed that the petroleum geology of our ocean areas is very complex, like that in China's eastern continental basin and the basins of Southeast Asia. Speaking with this in mind, we must apply ourselves in the utilization of the latest marine seismic technology, make for a more widespread use of 3-D and high resolution exploration in even more areas, improve the most advanced seismic data collection, processing and interpretation techniques to develop China's petroleum resources at a quicker pace and more economically.

12663

CSO: 4013/215

## OIL AND GAS

### EMERGENCY ENGINEERING MINIMIZES HUANG HE PIPELINE BREAK DAMAGE

Daqing YOUTIAN DIMIAN GONGCHENG [OILFIELD SURFACE ENGINEERING] in Chinese Vol 3, No 2, May 84 p 25

[Report by Meng Zhaoping [1322 2507 1627]]

[Text] The Huianbao--Zhongning section of the Changqing oil field pipeline crossing the Huang He burst suddenly on 10 September 1983. The situation was further aggravated by the weather--autumn is well advanced by the middle of September in the Ningxia region and the climate is very changeable. The water in the 800-meter-wide Huang He flowed past the damaged pipeline at a rate of 2.5 m/sec and washed it away; moreover, because of the rapid currents, divers were unable to right themselves underwater so that it was difficult to assess the extent of the damage. A meeting was called to deal with the crisis and an emergency group was formed for round-the-clock, on-site repairs. With the support of the Gansu and Ningxia party committees and petroleum department leaders, and with the active assistance of troops in the Moubudanqiao regiment at Lanzhou, the army and citizens worked hand in hand to brave the rapids and force their way through mud on both banks of the river. In spite of the extremely adverse conditions the emergency repairs eventually succeeded.

Temporary oil transport trucks were first sent to the Gunquan and Shikongbeng stations on the east and west banks, respectively, and transport was speeded up so that only 5 days were required to move the oil to the processing plant. Fifty-two tankers loaded oil day and night and hauled a total of 7,772 tons of crude oil, thus permitting production to continue and giving workers time for emergency repairs.

While this was going on, the Moubudanqiao regiment at Lanzhou constructed pontoons on the river. At the suggestion of the Oil Field Design Institute, oil separators and 4-inch diameter sections of high-pressure drill hose, combined end-to-end to form flexible connectors, were used successfully to join the floating pipelines on the pontoons to the fixed pipes on the river banks. The army and civilians began work on 20 September, and only 6 days were required to construct two 400-meter-long pontoons. The oil-field engineering corps layed down a temporary 1815-meter-long oil pipeline over the pontoons, and oil flow was restored on 29 September.

Since there was no assurance that the temporary pontoons would last through the winter, it was necessary to find a way to construct multiple lines in the short period of time remaining. Comrades at the Research Institute of Pipeline Design

suggested repairing the ruptured section by inserting a Dg 200-mm line into the original Dg 350-mm pipeline, provided that the ruptured section had not been displaced too far. Attempts to do this were successful and the opposite bank of the river was reached using 1,014.8 meters of pipeline. Test at full pressure on Oct 30 were successful and the pipeline was formally put back into operation.

The successful bypass operation kept the pipeline from breaking. The writer attributes the initial rupture to the following causes: 1) The pipeline was not promptly placed in its guide channel, which was blasted in the river bed during construction; as a result, the channel quickly filled up with mud and sand. During the emergency repairs it was found that just 58 meters from the western valve chamber the pipeline had been washed downstream by a distance of 8 meters, which suggested even greater displacements toward the center of the river. We thus infer that the pipeline was not properly seated in its channel during construction but merely laid down on the river bed. 2) During the several years after the pipeline began operating, the east bank of the river eroded eastward by more than 100 meters and exposed the unprotected pipeline formerly on the other side of the river. An eventual rupture was thus inevitable. In addition, stress was concentrated at the ends of the pipe casings, which were therefore particularly susceptible to damage. In the future it will be necessary to carefully allow for shifting of the river beds, and projects must be engineered in strict compliance with requirements in order to ensure a long pipeline life.

12617

CSO: 4013/4



## OIL AND GAS

### QINGHAI MEDIUM-PRESSURE PROCESS TRIALS OUTLINED

Daqing YOUTIAN DIMIAN GONGCHENG [OILFIELD SURFACE ENGINEERING] in Chinese  
Vol 3, No 2, May 84, p 56

[Report by He Bi [0149 4581]]

[Text] The Qinghai Petroleum Management Department is actively preparing to open up the Duosikule oil field, which has a hot, high-pressure reservoir with a low saturation pressure. The low-viscosity, high-wax-content crude has a high solidifying point, the geology is complex, and the oil field lies 3,000 meters above sea level, so that the atmospheric pressure is low. New oil field surface engineering technologies of the 1980's will be needed to fully exploit the light oil and liquefied gas contained in these reserves and to reduce energy, oil, and gas losses; specifically, a room-temperature, airtight, medium-pressure process for separating oil and gas and mixing and transporting the products is needed. In July 1982 an oil well was drilled, an oil-gathering pipeline and a flow-measuring station were built, and on-site tests were carried out between 30 January 1983 and 23 April. Some 30,000 bits of data were recorded during the 84 days the well was in continuous operation. The tests measured the oil temperature at the wellsite, the flow-deformation properties of the oil-gas mixture, and the amount of paraffin precipitation in the pipeline; paraffin removal techniques, medium-pressure separation methods, and techniques for laying down pipelines in salty marshlands were also investigated. In all cases the tests were productive. The final surface engineering plans were recently completed with the guidance and assistance of the General Planning Institute of the Petroleum Department.

12617

CSO: 4013/4

## OIL AND GAS

### LAIOHE STEAM INJECTION TESTS ENCOURAGE ENGINEERS

Daqing YOUTIAN DIMIAN GONGCHENG [OILFIELD SURFACE ENGINEERING] in Chinese  
Vol 3, No 2, May 84, p 61

[Reported by Wang Wenjie [3769 2429 2638]]

[Text] The Liaohe oil fields contain extensive reserves; 1,918 tons of crude are produced daily by the Shu-1 and Huan-17 fields. The steam-injection technology for 7-inch pipe casings is now past the initial stage, and the heat-insulating columns in the pit shafts, the high-temperature seals, and the heat-extracting equipment are essentially up to engineering specifications, so that production plans may now proceed and 1,600-meter-deep high-pressure, high-water-content and 1,000-meter-deep low-water-content injectors can be completed. Wells generally yield more crude oil after steam injection (the daily production during the initial period after injection usually exceeds 20 tons). In 1983, 23 wells out of a total of 31 wellsites were fully steam-injected and the total crude oil production rose by 61,000 tons. For example, well 1-35-32 in the Shu-1 field contains viscous oil (535/centipoise at 70°C) which cannot be extracted by ordinary techniques. After steam was injected, however, blowout occurred; the oil was then separated and mixed with thin crude, and up to 40-50 tons can now be produced per day. In 1984 the Liaohe technicians made a new breakthrough in crude oil extraction, and there is reason to hope that steam injection and admixture with thinner crude may reduce the viscosity enough to permit full-scale production.

12617  
CSO: 4013/4

## OIL AND GAS

### FALLING GROUNDWATER FORCES DAGANG TO TRY SEAWATER INJECTION

Daqing YOUTIAN DIMIAN GONGCHENG [OILFIELD SURFACE ENGINEERING] in Chinese  
Vol 3, No 2, May 84, p 68

[Report by He Anming [6320 1344 2494]

[Text] The Dagang oil field borders the Bohai Sea, yet for many years well water has been used both by industry and by the residential population. The continual increase in water consumption by the oil field has caused groundwater levels to drop, and the shallower wells are running dry. A water processing facility and experimental equipment for injecting seawater into the oil wells have therefore been set up in order to supplement Dagang's water supply; this work has been carried out with the cooperation of various groups, including the Research and Planning Institute of the Dagang Petroleum Management Bureau, the Geological Research Institute, and the Natural Gas Management Bureau, the Geological Research Institute, and the Natural Gas Management Office. The experimental injection station, which was planned in 1981, built in September 1982, and put into operation on a test basis in October, has been operating normally. It serves as an intermediate test station with a daily processing capacity of 300 m<sup>3</sup>. Processing is carried out in the following sequence: seawater collection → precipitation → filtration → deoxidation → sterilization → stabilization → injection into water pump → pumping into wellsite. Comprehensive analyses of the quality of the seawater after processing indicate that all of the technical specifications for injection are met. For example, the processing treatment reduces the rate of metal corrosion from 33.3 mil/year to 5.5 mil/year; this can be reduced still further, to 3.0 mil/year or less, by adding corrosion retardants to the water. Since the station began injecting processed seawater into the oil wells in July 1983, no malfunctions have occurred and all the technical indices are stable. Work continues of testing and measuring the corrosion rate, penetration coefficients, and other properties, and seawater injection tests remain in progress.

12617

CSO: 4013/4

## OIL AND GAS

### MAKING THE OIL FIELD A RAW MATERIAL BASE

Beijing YOUTIAN DIMIAN GONGCHENG [OILFIELD SURFACE ENGINEERING] in Chinese  
Vol 3, No 1, Feb 84 pp 1-6

[Article by Jin Yusun [6855 3022 5549]: "Make Full use of Oil and Gas Resources, Speed Up Construction of Raw Material Projects"]

[Text] Abstract

Based on the experience gained in the construction of the Daqing ethylene plant, the author discusses the favorable conditions and the present difficulties in developing the petrochemical industry and making the oil fields as a raw material base. In the coming years special attention should be placed on the study and design of key engineering projects and the organization and training of production management personnel.

The 300,000-ton Daqing ethylene petrochemical plant is one of China's modern large-scale petrochemical enterprises that use the oil field as a raw material base. After the successful development and construction of the Daqing oil field, it marks the new phase of integrated utilization and development of the petrochemical industry under the policy of self-sufficiency.

In the 1960's, the Daqing oil field became China's important petroleum energy base. In recent years, large-scale general petrochemical enterprises have been subsequently established. In the near future petrochemical plants will also become a major Chinese raw material base and provide the needed petroleum and synthetic materials for the four modernizations.

The Rich Resources in the Oil Field Are the Basis for the Development of the Petrochemical Industry

Since 1976, the Daqing oil field has been producing 50 million tons of crude oil and large quantities of associated gas every year. Steady production is expected to last until 1990 or even later. This is an unusually favorable situation for developing the Daqing oil field into a petrochemical raw material base.

In the 1970's, plants have been built in Daqing to produce 300,000 tons of synthetic ammonia and 480,000 tons of urea per year using the associated gas as the raw material. The Daqing ethylene petrochemical plant currently under

construction uses the associated gas as the principal raw material and will extract the heavy constituents to the maximum degree and recover the volatile light fraction easily lost in the accumulation and transportation of the crude oil.

In order to assess the petrochemical raw material information at the Daqing oil field, sampling and analysis have been made since 1975 of the Daqing crude oil transported in different modes at transfer stations, dehydration stations, reservoirs and collection points in the oil field and at loading docks and petrochemical plants in Dalian, Qinhuangdao, Nanjing, and Shanghai. More than 100,000 pieces of data on the light fraction contents were obtained using "crude oil direct entry chromatography". More than 93.7 percent of the total crude oil production at the time were sampled and analyzed. The analysis showed that the Daqing crude oil had a rich content of light fractions before C<sub>5</sub>. At the various stages, the light fraction contents (percent by weight) are:

|  |       |
|--|-------|
| Sealed crude oil before dehydration                    | 2.123 |
| After at least one opening                             | 1.786 |
| Outgoing crude after at least two openings             | 1.667 |
| Oil transported to various users in China<br>(average) | 1.364 |

In May 1983, after 8 years of surveys and monitoring, the light fraction content of Daqing's dehydrated pre-C<sub>5</sub> oil was 1.61 percent by weight. Based on the actual amount of oil processed in the crude oil stabilization device, the latent content of the light hydrocarbon in the crude oil that can serve as ethylene raw material is 720,030 tons per year.

The associated gas produced in the Daqing oil field is another important raw material for the petrochemical industry. Based on the initial oil gas ratio, the Daqing field produces 2.207 billion cubic meters of associated year per year. The latent content of the C<sub>2</sub>-C<sub>7</sub> hydrocarbon ethylene raw material is 736,200 tons per year and makes up 34.96 percent by weight of the total associated gas production.

The total amount of the light hydrocarbon latent content in the crude oil and the associated gas produced by Daqing field is 1.4 million tons per year. According to the assessment of the experts, as a petrochemical base, the Daqing oil field, will be able to provide the ethylene petrochemical plant sufficient raw material if the ethylene raw material construction project can extract the light hydrocarbon with the appropriate technology and the production management can be strengthened to improve the technical level.

In the past, due to various circumstances, the petrochemical raw materials in oil fields were not extracted and recovered. The light fraction contents in the crude oil have mostly evaporated in the collection and storage process due to lack of sealing. This was not only a loss in energy but also a loss of petrochemical raw materials. The heavy components in the associated gas were also burned as regular fuel. All these were unfortunate losses.

Based on 20 years of oil field construction experience, the Daqing oil field learned from advanced technologies here and abroad and formulated our own ethylene raw material recovery plan that suits the local situation. In this plan, we shall extract the volatile light fractions from the crude oil and recover the  $C_2-C_7$  heavy components from the associated gas and deliver them to the ethylene petrochemical plant in the liquid form.

In the development of the petrochemical industry, the oil fields are good bases of raw material. The rich raw material resources at Daqing provide sufficient feasibility for this enterprise.

#### The Advances in Oil Field Technology Have Created Favorable Conditions for the Development of the Petrochemical Industry

As stated above, the Daqing oil field has a rich reserve of petrochemical raw materials. The extraction, recovery and transport of these raw materials, however, require a series of applicable and reliable technologies. The continuously advancing technologies in the oil fields have created favorable condition for the development of the oil fields as bases for petrochemical raw materials.

##### 1. The processing technology for the associated gas has matured

In the late 1960's, the Daqing oil field began to supply raw material gas to petrochemical facilities to meet the needs of hydrogenation in the petroleum refining process and the production of chemical fertilizers. In the central part of the oil field, the first gas compressing station for gas export was built. The associated gas was collected, compressed to 8-10 kg/cm<sup>2</sup>, cold purified with ammonia absorber at -20°C and then shipped out. This oil field gas compression station was designed and built by the Chinese using domestic equipments. After 16 years of operation, the design and construction have been proved successful and the technology is workable.

Based on this experience, the Daqing oil field also provided gas to the 300,000-ton synthetic ammonia and the 480,000-ton urea facilities in the late 1970's and designed and built three more gas compression stations eight times the size of the first gas compression export station.

In the ethylene raw material engineering project, the Daqing oil field has imported three sets of the associated gas precooling and collection equipments and eight sets of ethylene glycol dehydration and gas collection devices. They have mostly been tested and put into production use and the results have been satisfactory.

Along with other developments at Daqing, the associated gas processing technology has also gained maturity. In the process of supplying gas to the petrochemical facilities, a great amount of liquified hydrocarbon was recovered in the 8-16 kg/cm<sup>2</sup> compression and -20~-25°C absorption refrigeration and compression refrigeration processes. This is precisely the useful component of the ethylene raw material. Based on the current production level, 0.57-1.36 tons of light hydrocarbon can be recovered from every 10,000 m<sup>3</sup> of associated gas

processed. When the ethylene raw material project is completed, the process rate of the Daqing associated gas can reach 78 percent with the light refrigeration and deep refrigeration separation devices.

With the exception of the deep refrigeration separation device yet to be built, the associated gas processing effort in Daqing has accumulated some design, construction and production management experience. The technology is mature and reliable enough to expect a 50 percent recovery of the ethylene raw material from the oil field associated gas.

## 2. Low-pressure gas collection technology has been very successful

The oil mining method at the Daqing field is water injection at the early stage and spontaneous ejection. The gas contains saturated water at a low separation pressure (the oil gas separation pressure is usually less than  $1.5 \text{ kg/cm}^2$ ). Since the oil field is located in a cold climate region and the separation and collection of the associated gas are scattered, the collection and transport of the associated gas is difficult.

To solve this technical problem in production, the technical staff and workers at Daqing have conducted extensive testing and research. They have completed and perfected a low-pressure gas collection technique. Their gas collection system is basically a self-pressure system and makes good use of the oil gas separation pressure to save energy. The installation of pressure-boosting stations and parallel oil and gas pipes allow the heat from the crude oil transport pipe to be used for freeze prevention. After 3 years of successful operation, the method has been proved simple and practical and the number of pressure-boosting stations of the original design was reduced by 38 percent and the number of glycol dehydration stations was reduced by 61 percent. Today, the low-pressure gas collection method is widely used in the Daqing field and has worked well.

## 3. The associated gas collection technique has proved itself in production

In order to solve the seasonal imbalance in the production and consumption of the oil field associated gas, China built its first underground gas storage facility in the early 1960's. After 20 years of production, the technique has proved itself and the recovery rate is better than 85 percent.

To ensure uninterrupted supply of raw material gas to the ethylene plant, underground storage with a combined capacity of 10.9 times the first underground storage facility are being built at the proper locations in the oil field. After their completion, the seasonal imbalance of associated gas production will be alleviated and the losses will be reduced.

## 4. Good results have been obtained in improving the closed cycle crude oil collection and transport and the crude oil stabilization technique.

In order to extract the volatile light fraction contents in the crude oil, the crude must first be stabilized. The prerequisite to the stabilization process is



a closed flow cycle. To this end, the Daqing field, together with the ethylene raw material program, has modified the unclosed or poorly closed flow cycles from the early years. The original unsealed flows were converted to single well intake, and flows mixed with activated water and centrally heated with hot water. The heating furnaces at the well openings and the trunkline heaters were therefore eliminated. The flow closures in newly constructed and existing transfer stations and in dehydration stations are achieved by hydrocarbon vapor recovery devices and pressure balasts.

After proper distribution, the purified crude oils are concentrated in a number of dehydration stations and the negative pressure outgassing process is carried out under -200 to -300 mm of mercury and at 50-60°C. With the C<sub>6</sub> extraction rate controlled at less than 6 percent, the average gas recovery rate of the entire oil field is 0.482 percent by weight. The recovered gas is first water cooled to obtain the liquid hydrocarbons and the uncondensed part is further refrigerated for more recovery of liquid hydrocarbons.

Based on an investigation of the ethylene resources, the average loss of the pre-C<sub>5</sub> light fraction contents from the oil well to the output port of the oil field is about 0.555 percent by weight. After the flows are sealed and the stabilization process performed, 80 percent of the evaporation loss may be recovered as ethylene raw materials and the C<sub>6</sub>-C<sub>12</sub> heavy constituents that were originally lost can also be retained in the crude oil. As a result, not only the petrochemical raw materials are recovered from the loss, the heavy components are also kept in the crude oil.

Since 1977, the Daqing oil field has worked on the sealing of the crude oil collection flow at Lamadian and Xingshugang to reduce the losses. The flow closures were improved and perfected by the mixing of activated water. In the meantime, negative pressure outgassing stabilization facilities were constructed and the total recovery of the light fraction contents has reached 0.74 percent by weight.

In the ethylene raw material program, the crude oil stabilization process will be further improved by using imported technology. The defects will be corrected and the design and construction will be made to suit the situation of the oil fields in China.

Based on the preliminary results, it is expected that, after the completion of the flow closure and crude oil stabilization, the total loss in the oil field will be reduced to below 1 percent and the gas loss in the collection and transportation of the crude oil will be reduced by 40 percent. This is expected to provide the other half of the ethylene raw material to be recovered from the crude oil.

##### 5. Testing and application of other technologies have produced initial results

In order to open up new areas in oil field construction in China and to make the oil field a base for petrochemical raw material, the Daqing field has in recent years not only applied the gas processing technology but also conducted extensive testing and investigation of other technologies and obtained good



results. These other technologies include the removal of the water and light hydrocarbons in the associated gas by expansion cooling, the selection and deployment of compressors suitable for the specific conditions of Daqing, transportation of light hydrocarbons, dehydration, and hydrocarbon vapor recovery from the oil tanks.

In the next year or so, further studies will be made for the measurement and storage of associated gas and light hydrocarbons, the pressure regulation of the dry gas return and the stabilization of the supply.

The production-proven, successful and effective research results and technological advances have provided a set of favorable conditions for the development of petrochemical industries in the oil fields.

#### Large Construction Projects and Complex Technology Created Difficulties in the Development of the Petrochemical Industry

Even with abundant resources and mature technology, the oil fields cannot necessarily become a raw material base for the petrochemical industry or easily satisfy the raw material needs of the ethylene plant. In the Daqing oil fields, it must also be recognized that the ethylene raw material project is large and complex and must be given sufficient attention. Based on the recent construction and production experience, difficult tasks are expected in the technological design, plant construction and production management and success will not be forthcoming without some hard work.

##### 1. Large-scale construction

The 300,000-ton ethylene plant at Daqing is one of China's high-priority construction projects. As compared to the conventional oil field construction, this project is not only more complex but also greater in scale. In addition to the main body construction of oil and gas collection and transport, there will also be water and electrical power supply, road construction, machine maintenance, well construction and fuel structure modification. It will have more than 300 large stations and facilities, 400 medium and small stations, almost 4000 kilometers of pipes, lines, and roads and other associated construction. The total investment will be equivalent to the combined capital investment of the first 7 years of the Daqing oil field construction. It is by no means an easy task to complete the ethylene raw project while maintaining a high and steady output at the oil field.

##### 2. New and complex technologies

To the oil field workers and producers at Daqing field, the mining of crude oil, engineering construction and production management are familiar activities. But the design, construction, and production management of the oil and gas processing still require more knowledge and skill even though some practical experience has been accumulated in the last few years. In many areas we will have to explore as we go along because a number of the construction and technology are first time experiences in the history of China's oil field construction.

### 3. New and inexperienced crews

To meet the production needs of ethylene raw material, Daqing has recently established a natural gas company to assume the responsibility of oil gas reprocessing for the entire oil field. But the team is new and inexperienced and still cannot satisfy the requirements of production and technological development even though there have been technical training, short courses, off-site training, expertise recruitment and personnel quality improvement.

### 4. Scheme is tight and some technologies and equipment are not available domestically

The Daqing ethylene facilities are scheduled to have their test run in 1986, only 2 years from now. It will be rather difficult to ensure the timely supply of raw materials.

In particular, the difficulties discussed above are mutually constrained. This will make the normal construction and production even more formidable.

### Make Overall Arrangements and Continue the Effort To Build the Ethylene Plant

To construct the ethylene plant and make Daqing oil field a petrochemical base, the following tasks must be thoroughly carried out in the next few years.

#### 1. Equipment order and material supply for priority projects

The ethylene raw material program has greatly exceeded the traditional scope of oil field construction. The oil gas reprocessing facility will require various compressors, light hydrocarbon pumps, storage tanks and special valves, and measurement and analysis equipments. They are crucial components of the project and in principle will be manufactured and assembled in China. Component and equipment manufacture still has not achieved maturity in China and deadlines are often missed. The import of equipment and components must be properly handled to prepare for the design and construction.

#### 2. Design and research should be done according to urgency

Major constructions in the ethylene raw materials program such as the oil gas reprocessing plant, the deep refrigeration separation facility, and the light hydrocarbon storage tanks are all specialized projects and take relatively long design time. The work must be done according to the capital construction procedure and the design plans must be deliberated and evaluated six months before the construction begins.

Conventional items in the oil field construction should be planned and designed using technological improvements. The basic data must be scientific, accurate, and reliable. To insure design quality, each technical item in the design must be thoroughly and repeatedly discussed and the difficulties and adverse factors must be given adequate considerations. Large engineering constructions must be given at least 6 months of test production period for modifications, management improvements, personnel training, and consolidation of design and construction experience.

### 3. Organization and deployment must be done well

The ethylene raw material construction program involves many facets. From the collection of oil and gas, to reprocessing and finally to product output, the program has the common features of oil field and gas field constructions. Therefore, the construction tasks must be planned in a unified manner. The constructions, according to the special nature, should be worked on separately to improve productivity and economic benefits.

The state-approved economic accounting guidelines must be adhered to closely and the management should be strengthened so that the investment is controlled carefully.

### 4. Speed up the training of the production management personnel

A competent production-management team must be trained to put the ethylene raw material engineering project into production. The production technology in the oil field has progressed from the oil well, pump station to pressurization station and processing plant, and from separators and water-jacket furnaces to compressors and flash evaporation towers. But the experience for constructing ethylene plants is still lacking. Therefore, the production management personnel, including leading cadres, engineering staff and workers, must raise their technical level accordingly to meet such changes and transitions. In the production of the raw materials, highly automated high-temperature, high-pressure, and cryogenic technologies are required. In the next few years, along with the construction of the raw material facility, production management personnel must be quickly trained to meet the new situation and new challenges and the director's office should be gradually completed.

### 5. Continue to work on the basics

The basics are the scientific basis of the ethylene raw material program. Some work has already been done. Through the raw material construction, the Daqing oil field is prepared to carry out a long-term effort in the analysis of the light fraction contents in the crude oil and in the analysis of the associated gas.

The successful transition of the ethylene raw material plant into production relies on the success of a number of scientific research projects. In China the petrochemical industry is still in the beginning stage and it is even newer for an oil field to move in this direction. Exploration must be done in many technical areas and scientific method and perseverance must be used to complete a series of research projects that serve the raw material program, such as dry gas return, light hydrocarbon dehydration and storage, crude oil stabilization and improved light fraction recovery.

In the meantime, we must also strengthen external coordination and learn from the experienced units and from institutes of higher learning and scientific research in China. We should also learn from abroad and improve our technical standard by absorbing other's strengths and overcoming our deficiencies. There are also plans to systematically send workers out for learning, observing, and

training, and to invite specialists to the oil field to lecture and guide the research experiments on special topics so that the design, construction and production management of the ethylene plant can be improved.

By building an ethylene plant on the oil field, the oil field workers have made a step in a new direction. With hard work and scientific attitude, the mission will certainly be accomplished.

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CSO: 4013/165

## OIL AND GAS

### OIL AND GAS CONTENT OF SICHUAN BASIN LIMESTONE EVALUATED

Beijing SHIYOU XUEBAO [ACTA PETROLEI SINICA] in Chinese Vol 5, No 1, 1 Jan 84 pp 9-17

[Article by Huang Jizhong [7806 4694 0022], Sichuan Petroleum Administration: "On the Occurrence of Oil and Gas in the Yangxin Limestone Series in Sichuan Basin"]

[Text] Abstract

In light of the oil and gas distribution in the Yangxin Series in Sichuan Basin and the geochemical characteristics of the soluble and insoluble organic materials contained in the rocks, the author attempts to prove that the black and gray colored argillaceous micritic limestones are good source rocks, and that their geochemical indices are close to those of the source rocks of marine and continental origin in all known oil regions at home and abroad. Analysis of a number of parameters regarding the maturity of organic materials indicates that there are, in the basin, matured regions, highly-matured regions and over-matured regions, as well as immature regions. As the transformation of oil and gas is closely related to the maturity of organic materials, so is their distribution. In the opinion of the author, on the whole, the majority of the basin is in the highly-matured to over-matured state, so, with the exception of a few places where oil may be available, the basin is primarily gas-producing.

#### Foreword

Southern China has a wide distribution of Yangxin limestones of the Permian period which are stable and generally show indications of oil and gas. In the Sichuan Basin the Yangxin limestone forms one of the major gas-bearing strata. In this paper the author discusses the formation characteristics of oil and gas and the evolution systematics.

# I. Characteristics of Oil and Gas Formation in Yangxin Limestone

## 1. Primitive organic materials

The key in evaluating oil-bearing carbonatite is the primitivity of the organic materials it contains. This test is made according to the following three criteria:

(1) Macroscopic and microscopic observation of the surface rocks and under-well rocks in the Guangyuan mine in northeast and southeast Sichuan shows a close correlation between the distribution of organic materials and the host. The organic matter is closely related to argillaceous rocks and fossil.

(2) Judging from the variation of the stable carbon isotope  $\delta C_{PDB}^{13}$  in the gaseous and soluble organic matter, the carbonatite rocks show a normal distribution, that is, soluble organic matters contain more light  $C^{12}$  than insoluble organic matters, in agreement with the fractional distillation mechanism in thermodynamics (see Fig. 1). Since  $C^{13}-C^{13}$  is more stable than  $C^{13}-C^{12}$ , which in turn is more stable than  $C^{12}-C^{12}$  under the action of heat,  $C^{12}$  is more likely than  $C^{13}$  in the separation and precipitation in the soluble organic matters. This shows that the "micropetroleum" in the limestone originates from the organic materials contained in the rocks.

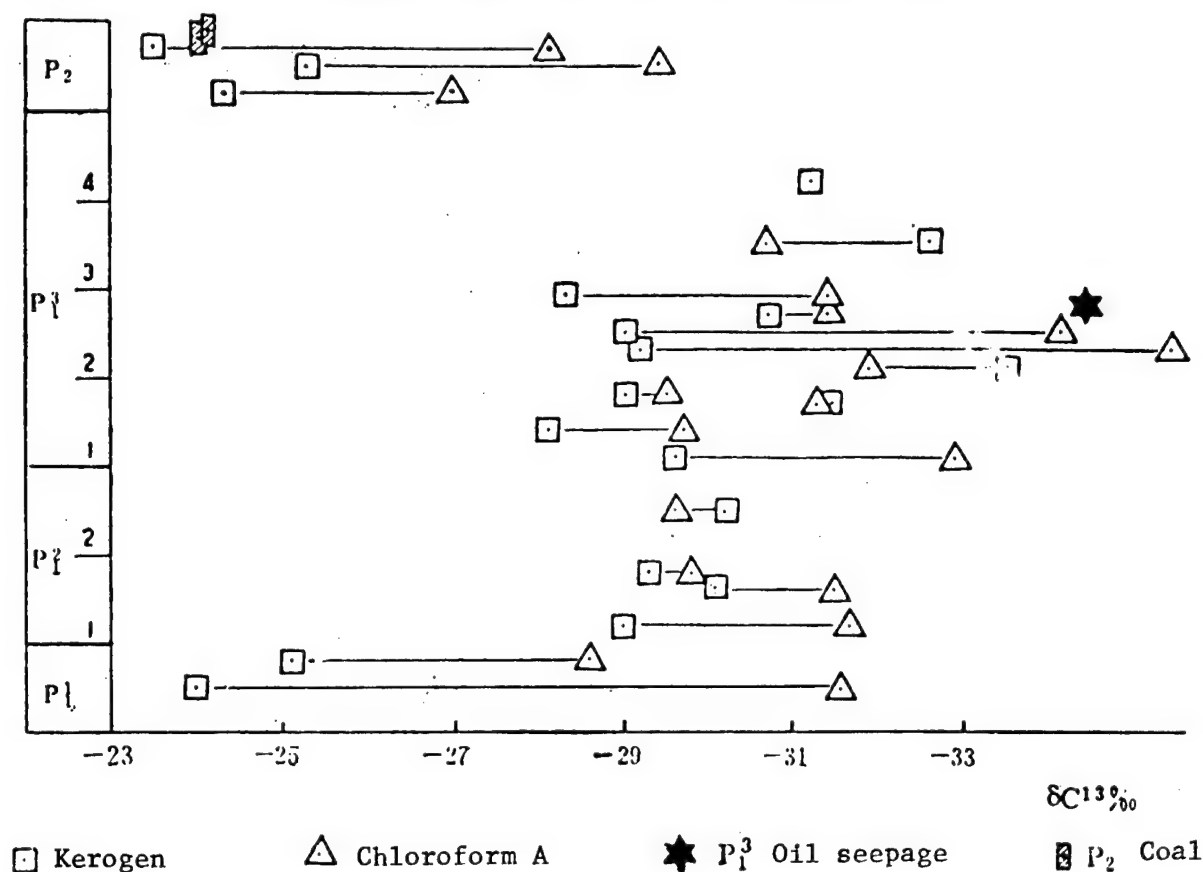


Figure 1. Distribution of carbon isotope in organic matter

(3) Judging from the relationship between the soluble organic material (chloroform pitch) and the organic carbon, one finds that in mature rocks (such as those at Guangyuan, Mingyuexia and Xingshan canyon) the organic material and the organic carbon show pronounced normal distribution and the content of the soluble organic matter goes with the content of the organic carbon. But rocks of a high degree of maturity (such as the same rocks in southeast and central Sichuan) do not show this relationship. Evidently the organic materials in highly maturational rocks have further evolved or separated and transformed into gaseous hydrocarbons.

## 2. Abundance of organic materials

According to statistics, the lower limit of the oil-bearing carbonatite is usually 0.20 percent. For similar organic materials, the higher abundance is usually more favorable. The organic content abundance analysis of the Yangxin limestone shows that:

(1) The abundance depends on the rock structure. The organic contents of the argillaceous rocks and the black and gray microlitic rocks are generally higher. For example, the content of organic matters of the gray and black microlitic rocks in the Maokou (P<sub>3</sub>) group is only next to the argillaceous rocks and is higher than that of the coarse structured rocks (see Table 1).

Table 1. Comparison of the organic matter content in different rocks

| Typical<br>C %<br>Color        | Rock<br>type | Argillaceous | Fine structured<br>carbonatite | Coarse structured<br>carbonatite |
|--------------------------------|--------------|--------------|--------------------------------|----------------------------------|
| Black ~ dark gray              |              | 0.74/18      | 0.52/98                        | 0.18/6                           |
| Gray                           |              | 0.38/2       | 0.21/57                        | 0.13/8                           |
| Light gray, white<br>and green |              | 0.10/5       | 0.03/16                        | 0.06/10                          |

(2) The abundance depends on the maturity of the organic materials. The hydrocarbon contents of the limestones in less matured regions are higher. The hydrocarbon concentration of the rocks in the mature Guangyuan mine in northeast Sichuan is a few ppm to 1,000 ppm. The average value for the black carbonatite with a fine structure is 592 ppm, and for the fine structured gray carbonatite the figure is 438 ppm. This hydrocarbon concentration is close to that of the oil-bearing argillaceous rocks here and abroad (see Table 2).

## 3. Types of organic materials

The Yangxin limestone contains kerogen and soluble organic materials favorable for gas and oil formation.

Table 2. Comparison of the hydrocarbon concentration

| Region                   | Sichuan<br>(Guangyuan<br>Kuangshan-<br>liang) | U.S.<br>(Delaware<br>basin) | U.S.<br>(Venturi-<br>Los Angeles<br>basin) | Canada<br>(Alberta) | Songliao<br>Basin |                       | Central<br>Hebei<br>depression         | Sichuan<br>(Gui 226<br>well) |
|--------------------------|---|-----------------------------|--|---------------------|-------------------|-----------------------|--|------------------------------|
| Stratum                  | P <sub>1</sub> <sup>3</sup>                   | P                           | upper<br>Miocene<br>series                 | K                   | K<br>Qing-1       | K<br>Qing-2<br>Qing-3 | Lower<br>tertiary<br>Shahejie<br>group | J <sub>1</sub> <sup>4</sup>  |
| Precipita-<br>tion phase | ocean   | ocean                       | land                                       | ocean               | land              | land                  | land                                   | land                         |
| Rock type                | Carbonatite                                   | Argilla-<br>ceous           | Argilla-<br>ceous                          | Argilla-<br>ceous   | Argillaceous      |                       | Argilla-<br>ceous                      | Argilla-<br>ceous            |
| Hydrocarbon<br>(ppm)     | 288-971<br>Ave 592                            | 875                         | 1,577                                      | 1,572               | 1,612             | 300-<br>1,000         | 289-546                                | 266-1,028                    |



(1) Scanning observation of the kerogen in the Yangxin limestone shows an irregular structure (Fig. 2A) [not reproduced] similar to the kerogen in the oil-bearing argillaceous rocks of the Cretaceous period found in Mexico (Fig. 2B) [not reproduced], and distinctly different from the  $P_2$  sapropelitic coal (Fig. 2C) [not reproduced]. On the H/C and O/C atomic ratio diagram of the kerogen, the Yangxin rocks fall between the type I and type II region.

(2) In terms of the stable carbon isotope composition of the kerogen, the Yangxin limestone generally has  $-28 \sim -33$  percent of the  $\delta C^{13}$  distribution of typical organic materials found in Sichuan basin. This is distinctly different from the  $-24$  percent organic material found in the swamp precipitation which is characterized by a rich content of the light  $C^{12}$  isotope. Based on the results reported by K. E. Peters et al<sup>6</sup> on the isotope evolution in the thermal simulation experiments of bog-head coal and mud coal, the carbon isotope value basically remains unchanged with respect to temperature and heat treatment time in the room temperature to  $550^\circ C$  range. The author has expressed similar view<sup>1</sup> in 1980 claiming that the  $\delta C^{13}$  value is primarily an indication of the composition characteristics and hence the types of the organic materials (see Fig. 3).

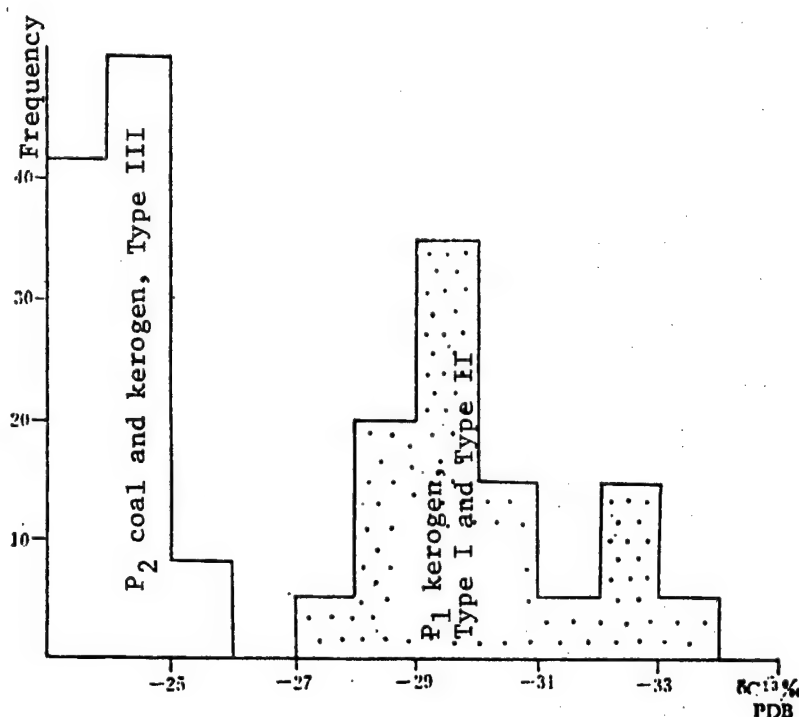


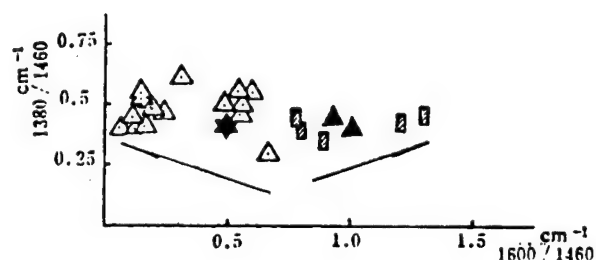
Figure 3. Carbon isotope characteristics of  $P_1$  kerogen and  $P_2$  coal

(3) Judging from the hydrocarbon composition of the chloroform pitch "A", the Yangxin limestone has the characteristics of oil and gas bearing rocks and is different from the coal series pitch. The chloroform pitch has a high content of hydrocarbons, mostly saturated hydrocarbons. The coal series pitch is rich in nonhydrocarbons and bitumen. This is because the

coal series (humus) chloroform pitch "A" originates from the xylem and cellulose of plants and is characterized by aromatic structures. On the other hand, the oil-like chloroform pitch "A" originates from protein-rich lower organisms and is characterized by a saturated structure.

(4) The infrared spectrum of the Yangxin limestone shows that it is different from coal pitch and is closer to petroleum. For example, the aromatic structure absorption peak at  $1,600\text{ cm}^{-1}$  is pronounced in coal but not in the fine-structured carbonatite. On the other hand, absorption peaks at  $1,380\text{ cm}^{-1}$  and  $1,460\text{ cm}^{-1}$  characteristic of methyl and sec-methyl are prominent in the carbonatite. The coal pitch may be easily distinguished from the petroleum by the ratios  $1,600\text{ cm}^{-1}/1,460\text{ cm}^{-1}$  and  $1,380\text{ cm}^{-1}/1,460\text{ cm}^{-1}$ . The chloroform pitch in the Yangxin limestone has the features of micro-oil and is an indicator for oil-bearing rocks (see Fig. 4).

The data described above show that the fine-structured dark argillaceous microlitic limestones are oil-bearing rocks and the carbonatites with a coarse structure are reservoir rocks. Their evolution is controlled mainly by the sedimentary facies and the cycles of sedimentation.



$\triangle$   $P_1$  chloroform pitch "A"

$\star$   $P_1$  crude oil

$\blacktriangle$   $P_2$  coal seam chloroform pitch "A"

$\blacksquare$   $P_2$  coal chloroform pitch "A"

Figure 4. Optical density ratio of the infrared spectra

## II. Geological Factors Controlling the Evolution of Oil-Bearing Rocks

After the Caledonian movement, part of the Sichuan Basin became deficient Devonian series and Carboniferous series and part of it became lower Palaeozoic. The Yangxin limestone sediment experienced a brief period of swamp ( $P_1^1$ ) sedimentation with a thickness generally less than 10 m, consisting of alumina shale, carbon shale and coal, and then became  $P_1^2$ , the normal terrestrial sea plateau facies. In 1978, Song Wenhai [1345 2429 3189] et al, classified the sedimentation mode and the sedimentation facies and observed local sea plateau, open-sea plateau, and bio-mud cone in the plateau sedimentation zone and open-sea continental shelf in the basin sediment zone, all enriched with organic matter. In contrast, the shallow beach phase does not favor the enrichment and storage of organic matter. The enrichment of organic materials in the various facies is shown in Fig. 5. The organic carbon content is 0.91 percent in organism mud cone, 0.57 percent in open-sea continental shelf, 0.47 percent in local sea plateau, 0.36 percent in

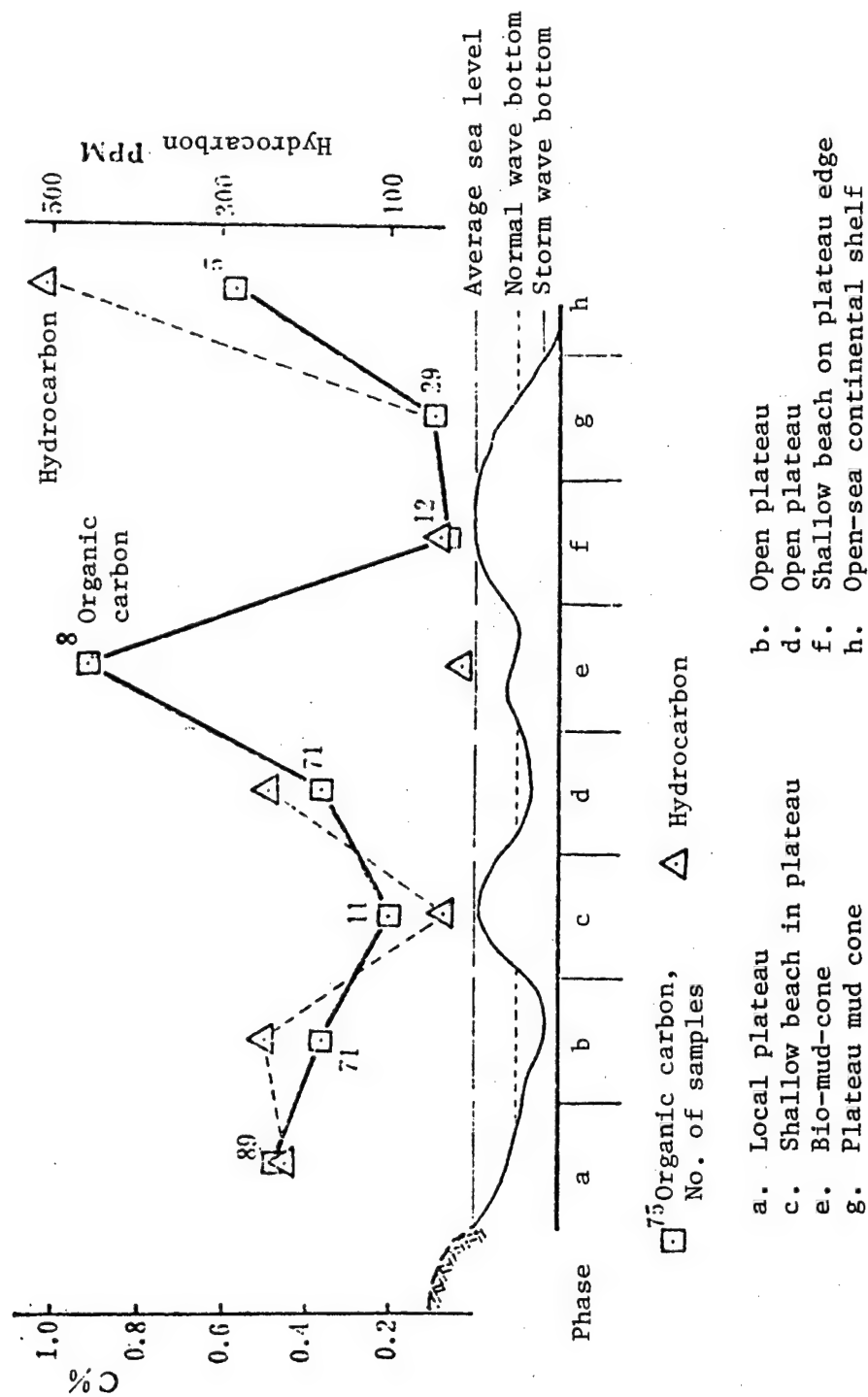


Figure 5. Organic matter enrichment characteristics in different phases of Yangxin limestone (Based on Kuangshanliang, Nujijing, Huajianshan, Xiangguoshi, Nanchuan, and Mengdong data)

open sea plateau, 0.20 percent in plateau shallow beach and 0.06 percent in plateau perimeter shallow beach. The hydrocarbon concentration varies considerably due to variations of the maturity of the organic matter.

The facies in the basin are clearly distinguishable in the vertical direction and the sediments are stable in the horizontal direction. In the early cycle of the sedimentation, the basin consists of the basin facies and the open and local sea plateau facies, the rocks are dark gray to black argillaceous microlitic carbonatite. In the intermediate and late cycles of the sedimentation ( $P_1^2$ ,  $P_1^{3_{2A+B}}$  and  $P_1^3$ ) the basin consists of the shallow facies and the rocks are the light gray, light brownish gray and white limestones with a coarse structure. The geochemical properties (abundance, carbon isotope value, saturated hydrocarbon chromatograph and the hydrocarbonization rate) of the various facies clearly show that sedimentation layers corresponding to the early stage of the sedimentation cycle has a high content of organic matters and are good locations for oil and gas formation. Layers of the middle and late cycles of the sedimentation generally have a lower organic content, but because of the coarse structure and the high porosity and percolation rate, they are superior for the storage of oil and gas.

The sedimentation facies are rich in organic materials because the Yangxin series was an extremely active period in the Paleozoic era for organism growth, not only the variety was great, such as foraminifera, fusulinids, scale insects, coral, brachiopods and zooecia, but there was also a great amount of algae, such as rhodophyceae and green algae, which the organisms lived on. In addition, such rocks are mostly fine-grained, argillaceous, and microlitic, and formed later than the rock formation by organism debris. They have a high ability for the adhesion of organic matters and a poor porosity and percolation, these make them good for keeping organic materials.

Conversely, the sediments in the high energy zone are mainly formed by remains of living organisms. In the specific sedimentation environment, even though the possibility for organic growth exists but because the organic materials in the high energy oxidation zone degradate in the biochemical reaction, the rocks formed in this environment are coarse and porous and the organic materials further degradate in the reaction with water and, as a result, the high energy zone sediments contain less clay minerals and have a weak adhesion ability for organic matters. They are therefore poor retainers for organic materials. When high abundances of organic materials do occur in such sediments, they are usually the result of local secondary enrichment.

The planar variation is generally small. For example, the thickness of the mature  $P_1^3$  dark fine-grained oil-bearing limestone in the basin is usually 150 m or so, equal to 50-70 percent of the total  $P_1^3$  thickness. Near the southeast perimeter and in the northern part of the basin, this could be as high as 80-90 percent. The concentration of the organic carbon in the basin is usually 0.5-1 percent except it is less than 0.2 percent in Baoxin in the west and in Wushan and Wuxi in the east. Regions with an organic carbon concentration greater than 1 percent are distributed near Jiangyou in northwest Sichuan and in local areas in the northeast and south Sichuan. The

amount of organic carbon per square kilometer as computed from the thickness of the oil-bearing rocks and the concentration is about 2 million tons and reaches 3 million tons in southwest Sichuan and near southeast perimeter (see Fig. 6). Using an area of 230,000 square kilometers and an average abundance of 2.5 million tons, the total amount of organic materials is 575 billion tons. Therefore, the Yangxin limestone has a great potential for yielding oil and gas.

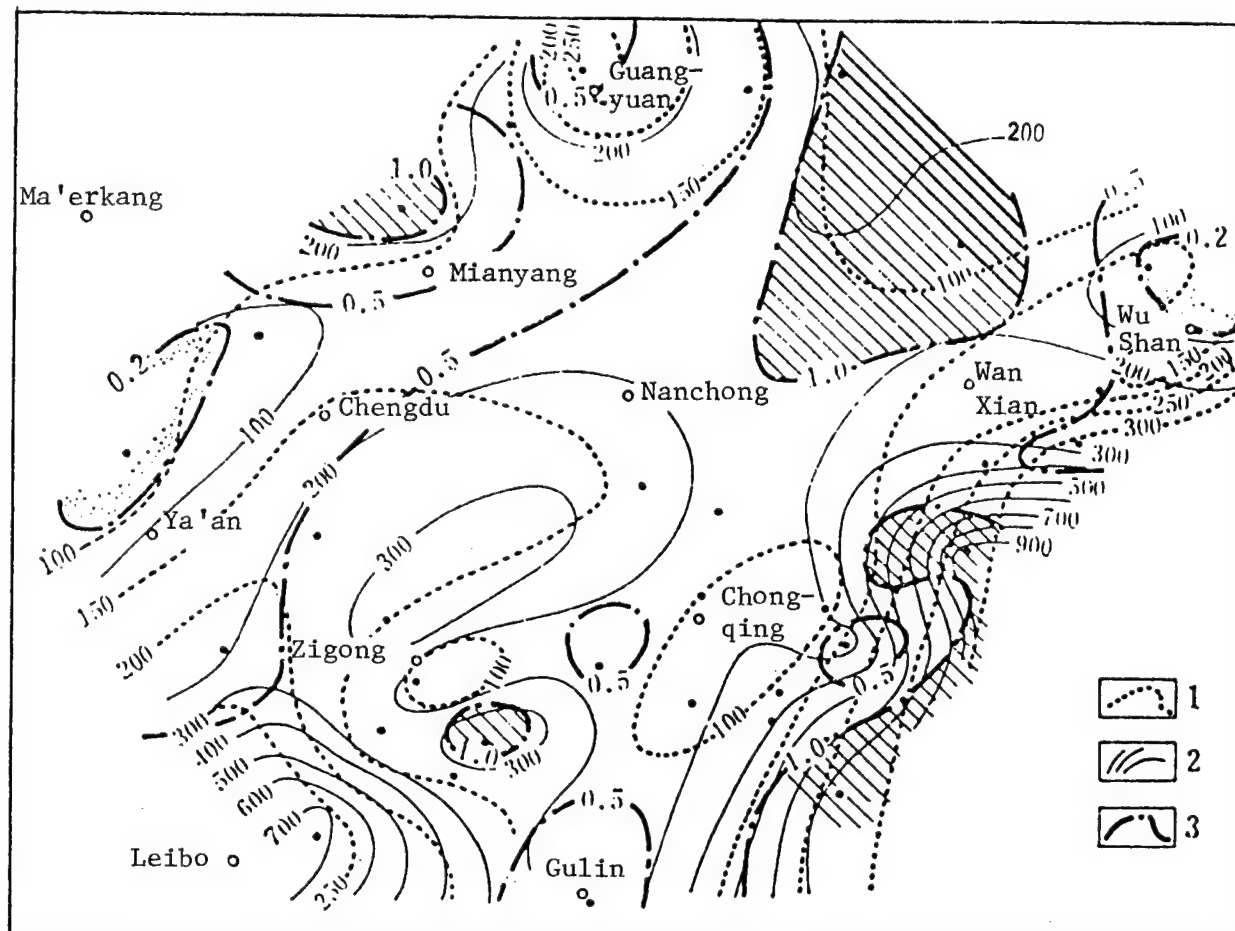


Figure 6. Organic abundance in  $P_1^3$  type I oil-bearing limestone in Sichuan basin

- 1--Constant thickness profile (meters)
- 2--Constant abundance profile (10,000 tons/km<sup>2</sup>)
- 3--Constant organic carbon profile (percent)

Note: Type I oil-bearing rocks are the black and dark gray argillaceous microlitic limestones.

Naturally, we cannot rule out the possibility of Permian coal gas entering into the Yangxin limestone, however, available data show that this is not the case. For example, in the Chongqing region the free (nonadsorbed) gas of the Zhongliangshan coal seam is characterized by a high methane content

(98-99.5 percent), a low hydrocarbon content (0.01-0.07 percent), a large methane coefficient ( $C_1/C_{2+3}=1,400-9,800$ ) and a negative (light) carbon isotope value for  $\delta C_{PDB}^{13}$  (-37.3 to -43.2 percent). As a contrast the natural gas in the Yangxin limestones in the gas fields near Shapingba and Xiangguosi just outside Chongqing has a lower methane content (97 percent or so), a higher content of heavy hydrocarbons (about 1 percent), a moderate methane coefficient (100-200) and a heavy carbon isotope value  $\delta C_{PDB}^{13}$  of -33 percent. This is clearly different from the coal gas.

### III. Control of the Organic Material Maturity

The Yangxin limestone sediment has an age of 2.8 million years and has experienced a number of diatrophic movements. Most of the organic materials in Sichuan basin have reached the highly matured stage or over-matured stage. This is why most of the drilling yields are natural gas. Today the deepest wells for industrial gas supply are 7,058-7,175 meters deep.

Because the Yangxin limestones in the various regions in the Sichuan Basin have a different geological history and are situated in different geothermal environments, the maturity varies in the horizontal direction. Based on the kerogen reflection law ( $R_{max}^o$  %), we divide the organic materials into matured regions, highly-matured regions and over-matured regions (see Fig. 7).

Judging from the horizontal variation of the maturity of the Yangxin limestones in the Sichuan Basin (Fig. 8), the matured regions are distributed in northwest Sichuan and along the frontrange of Dabashan, along the stretch northwest of Jiangnan and Gulu, and, in the interior of the basin, only in the local region between Qijiang and Nanchuan. The over-matured regions are distributed in the extreme southwest part of Sichuan, central Sichuan, and the part of southeast Sichuan near the edge of the basin. In between, the vast area of southeast Sichuan is a highly-matured region. The distribution of oil and gas generally coincides well with the distribution of the matured regions, oil seepages are generally seen in the matured regions and natural gas is found primarily in the highly-matured and over-matured regions.

In the Luzhou fossil bulge region, condensed oil or light petroleum can still be found today and the content of heavy hydrocarbons is therefore increased. This is because both the present burial depth and the ancient burial depth are relatively shallow in this region. Because of the bulge geomorphology, the sedimentation is thin and, more importantly, the erosion is strong. Not only  $P_1^3$  and  $P_1^4$  are missing, the Triassic continuous bulge has been eroded down to  $T_1^3$  and lost 800 meters. The temperature and time of this region are lower and shorter than the surrounding region and this is consistent with the fact that it is situated in the early highly-matured region.

We have calculated the TTI values of the Yangxin limestones in the Sichuan Basin (see Table 3). The TTI values of the regions with indication of oil are low and the TTI values of the regions with natural gas production are high, in basic agreement with the limiting value of the oil gas formation curve of W. W. Douglas.



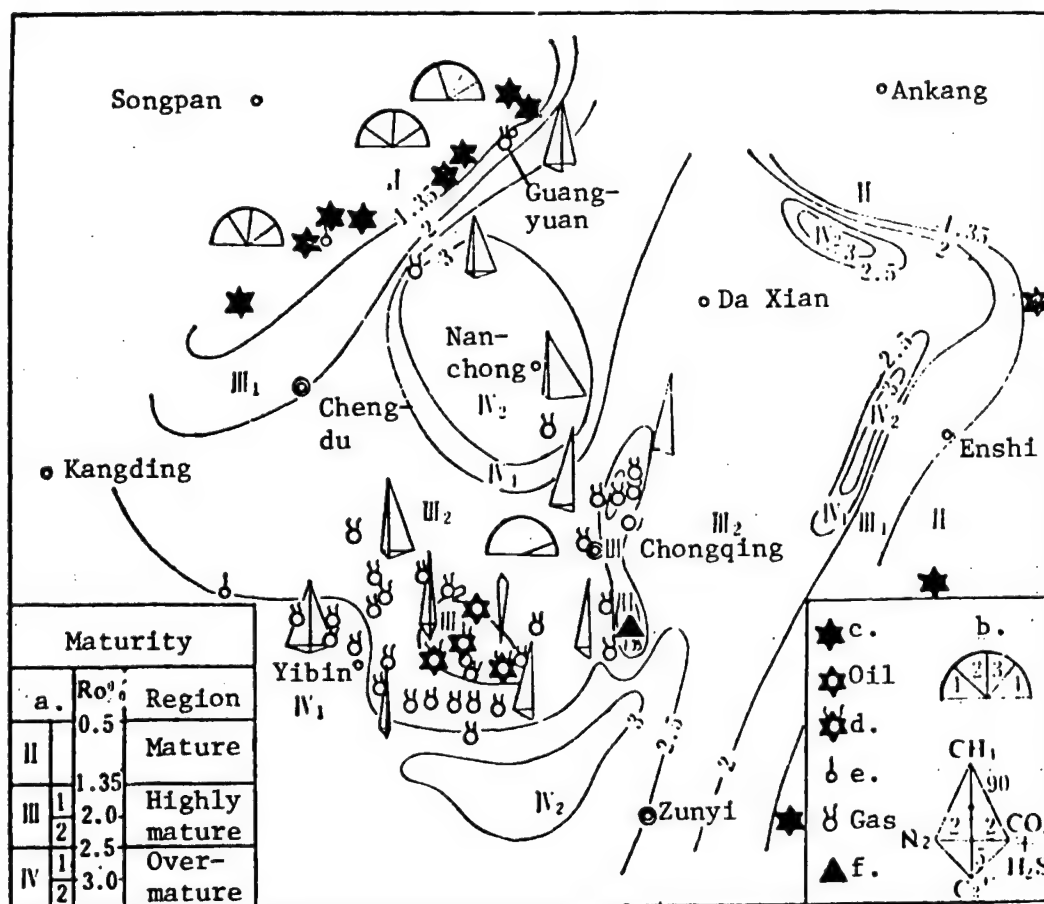


Figure 8. Oil gas distribution and maturity of  $P_1$  in Sichuan Basin



Table 3. TTI values of various  $P_1$  regions

| TTI values                       |                                 | Location | Northwest<br>Guangyuan<br>region | South<br>Luzhou<br>region | Central<br>Longnu<br>region | Remarks   |
|----------------------------------|---------------------------------|----------|----------------------------------|---------------------------|-----------------------------|---|
| Item                             |                                 |          |                                  |                           |                             |   |
| Annual ave. surface temp<br>(°C) |                                 |          | 16                               | 20                        | 18                          | Based on Well<br>Yu No. 1 for<br>Guangyuan                      |
| $P_1$                            | Temp gradient<br>(°C/100 m)     |          | 2.71                             | 2.90                      | 3.23                        |   |
|                                  | Max burial (m)                  |          | 2,850                            | 5,550                     | 6,850                       |   |
|                                  | Max temp section<br>(°C)        |          | 70-80                            | 130-150                   | 170-190                     |   |
| Ave temp gradient<br>(°C/100 m)  |                                 |          | 2.12                             | 2.46                      | 2.41                        | Thickness<br>weighted<br>average                                |
| TTI<br>value                     | $P_1$ top                       |          | 16.8                             | 545                       | 7,178                       |   |
|                                  | $P_1$ bottom                    |          | 20.6                             | 623                       | 15,726                      |   |
|                                  | $P_1$ ave                       |          | 18.7                             | 584                       | 11,452                      |   |
| Oil<br>formation<br>period       | Absolute age<br>( $10^6$ years) |          | 50                               | 153                       | 171                         | TTI > 15 for<br>oil formation                                   |
|                                  | Period                          |          | E                                | $J_3$                     | $J_{1-2}$                   |   |
|                                  | Temp section (°C)               |          | 70-80                            | 100-110                   | 100-110                     |   |
| Gas<br>formation<br>period       | Absolute age<br>( $10^6$ years) |          |                                  | 102                       | 152                         | TTI > 160 for<br>gas formation<br>(oil forma-<br>tion complete) |
|                                  | Period                          |          |                                  | K                         | $J_3$                       |   |
|                                  | Temp section (°C)               |          |                                  | 120-130                   | 140-150                     |   |
| Oil, gas indication              |                                 |          | Oil seepage,<br>pitch            | Gas con-<br>densed<br>oil | Dry gas                     |   |
| Kerogen ( $R_{\max}^\circ$ %)    |                                 |          | 0.5-1.35                         | $\sim 2^\circ$            | $3^\pm$                     |   |
| Maturity                         |                                 |          | Mature                           | Highly<br>mature          | Over-<br>mature             |   |

Although the values listed in Table 3 are based on the ground temperature gradient data measured electrically, they are still in agreement with the oil and gas evolution. Moreover, because of the Yangshan movement in Guangyuan region in northwest Sichuan, the Jurassic series and the underlying stratum are in angularly discordant contact and extending toward one side of the basin into quasi-discordant contact. As a result, the oil formation is in the early Tertiary period and this region is still in the oil-forming period. In south and central regions of Sichuan, however, the burial depth is great and the temperature gradient is high, their oil-forming period precedes the former by 1.03-1.21 million years and these regions are in the Jurassic period. In terms of gas formation, southern Sichuan is in the Cretaceous period and central Sichuan is in the late Jurassic period. In addition, favorable structures help the formation of oil and gas reserve and structures formed after the oil and gas formation period can only be candidates for the secondary movement.

### Conclusions

The Permian period Yangxin limestone in the Sichuan Basin possesses the features of oil-bearing rocks. The oil and gas originate from the same stratum and are primary oil and gas reserves. The black and gray microlitic carbonatites are oil-bearing rocks and the coarse bio-facies [?] carbonatites are storage rocks.

Oil-bearing rocks are characterized by a high concentration of organic materials and favorable types of kerogen. In large areas of high organic maturity, the oil has become natural gas. In regions of lower maturity, there are still indications of oil. Therefore, it is still possible to find oil in areas such as the Jiangyou region in the front edge basin in northwest Sichuan.

### References

1. Huang Jizhong, "Kerogen Classification Using Stable Carbon Isotope Value  $\delta C^{13}$ ," Petroleum and Experimental Geology, Vol 2, 1980.
2. Huang Jizhong, Gu Guohua [0657 0948 5478] and Feng Guoxiu [6265 0948 4423], "Experimental Simulation of the Open Thermal Evolution of Petroleum and Coal," Exploration and Development of Natural Gas," Vol 4, 1980.
3. Wang Hanyun [3769 3211 0061] and Yang Tianyu [2799 1131 1342], "Experimental Simulation of Thermal Dissociation Gas from Crude Oil," Natural Gas Industry, Vol 3, 1982.
4. Chekalyuk, E. B., "Thermal Chemical Transformations in Nature," Geological and Geochemistry, Vol 5, 1976.
5. B. P. Tissot and O. H. Welte, "Petroleum Formation and Occurrence," 1978.
6. K. E. Peters, B. C. Rohnback, and I. R. Kaplan, "Carbon and Hydrogen Stable Isotope Variations in Kerogen During Laboratory--Simulated Thermal Maturation," AAPG, 65/3.

OIL AND GAS

CONSTRUCTION OF NEW OILFIELD NEAR SINO-MONGOLIAN BORDER BEGUN

OWO40939 Beijing XINHUA in English 0645 GMT 4 Nov 84

[Text] Hohhot, 4 Nov (XINHUA)--Work has begun on the construction of a new oilfield near the Sino-Mongolian border, officials were announced today.

Test extraction will begin in 1985 in the Eren Basin, a 100,000-square-kilometer area in the central section of the Inner Mongolia Autonomous Region, where oil reserves are estimated at 1 billion tons (7 billion barrels).

To achieve the objective, exploration is being intensified in four promising oil zones, authorities said.

Projects already planned for the Eren oilfield include an oil refinery in Erenhot City, 4.5 kilometers from the Sino-Mongolian border.

The region plans to solicit foreign investment for the project. Establishment of joint venture projects and foreign technology deals are also envisioned.

The new Inner Mongolian petroleum exploration and development company is responsible for developing the oilfield. It came into being following an inspection tour of the area by Chinese Communist Party General Secretary Hu Yaobang in September.

He was said to have called for developing the oilfield "as quickly as possible" to boost Inner Mongolia's economy.

CSO: 4010/18

## OIL AND GAS

### NEW PETROCHEMICAL COMPLEX PLANNED FOR XINJIANG

OW120958 Beijing XINHUA in English 0758 GMT 12 Oct 84

[Text] Urumqi, 12 Oct (XINHUA)--China plans to spend more than 400 million yuan on building several large petrochemical plants in the southwestern part of oil-rich Tarim Basin in the Xinjiang Uygur Autonomous Region, according to Song Hanliang, vice-chairman of the regional people's government.

Scheduled for completion within 4 years, the new industrial complex will include an oil refinery, a chemical fertilizer factory, a liquefied natural gas plant, and a heat and power plant.

The new factories will use as their raw material crude oil and gas from an oilfield now under development. The Kekyar oilfield discovered in 1977 has verified reserves of 30 million tons of crude oil and 30 billion cubic meters of natural gas.

This is the ninth oilfield found in Xinjiang since 1955. Eighteen seismic prospecting teams are still working in the Tarim Basin.

CSO: 4010/18

## OIL AND GAS

### BRIEFS

YET ANOTHER LIAOHE RECORD--Making an outstanding contribution to China's National Day, the personnel of the Liaohe oil fields were producing more than 22,000 tons of crude a day as of 23 September, a 29 percent increase over the same period of 1983. This is an all-time high, exceeding the target set for first-quarter production. [Text] [Shenyang LIAONING RIBAO in Chinese 25 Sep 84 p 2]

CSO: 4013/28

## SUPPLEMENTAL SOURCES

### XIZANG BUILDS SECOND GEOTHERMAL POWER PLANT

OW090827 Beijing XINHUA in English 0737 GMT 9 Oct 84

[Text] Lhasa, 9 Oct (XINHUA)--Another geothermal power plant is being built at a new geothermal field in Ngari Prefecture in northwest Tibet.

The first geothermal power plant was built at Yangbajain geothermal field near Lhasa.

The new Lungjug geothermal field covers an area of 0.5 square kilometers. The water temperature at several dozen hot springs is up to 78°C. The flow generates 6,000 kilocalories per second. About 7,000 kilowatts in generating capacity may be installed, according to geothermal experts.

The power plant will generate enough electricity to meet the needs of a town near the geothermal field.

Geothermal power is a major energy source in Tibet, with reserves ranking first in the country. Up to the present, more than 600 geothermal areas have been discovered. Among them is the Yangyi geothermal area. With 69 hot springs up to 86°C, the area is even larger than the Yangbajain geothermal field, China's previous largest.

The other large geothermal fields found include those at Nagqu, Lhatoggang and Yuzhai, covering areas ranging from 4 to 10 square kilometers and water temperature ranges from 50° to 53°C.

According to energy experts, if development starts at 30 geothermal fields, 500,000 kilowatts in generating capacity may be installed.

CSO: 4010/9

## SUPPLEMENTAL SOURCES

### XIZANG DEVELOPS SOLAR, GEOTHERMAL, WIND RESOURCES

OW040922 Beijing XINHUA in English 0858 GMT 4 Oct 84

[Text] Lhasa, 4 Oct (XINHUA)--The government of the Tibet Autonomous Region plans to invest 71,850,000 yuan, almost one-fourth of its major capital construction funds this year, to tap energy resources, according to the regional energy department.

The region is building its largest hydroelectric power station, with a generating capacity of 10,400 kilowatts, in southeast Tibet. Construction of a number of small power stations with a combined generating capacity of more than 10,000 kilowatts is under way in the rural areas. Most of them are scheduled to go into operation this year.

Tibet has a large hydropower potential which is estimated at 200 million kilowatts, accounting for some 30 percent of the country's total. By the end of 1983 it had built more than 600 power stations of various sizes with a combined generating capacity of over 100,000 kilowatts, supplying electricity to cities, mines and a number of villages in the region.

Tibet also has abundant resources of geothermal energy. The more than 600 geothermal sites that have been found generate 694,000 kilocalories of energy per second--the annual being equal to that of three million tons of standard coal.

The Yangbajan geothermal experimental power station near the regional capital city of Lhasa is the largest in China. Developed over the past 10 years, the power station, with a generating capacity of 7,000 kilowatts, has become one of Lhasa's major electricity suppliers.

At present, a 3,000-kilowatt generator is being installed at the power station, bringing its generating capacity to a total of 10,000 kilowatts.

Geothermal energy is also used for heating and irrigation in many parts of the region.

To take advantage of the strong winds in the area, the Nagqu prefectural science and technology commission has supplied more than 100 herdsmen's families with a 100-watt windpower generator each this year. Living 4,500 meters above sea level, these families used to illuminate their tents with yak butter lamps.

Tibet's solar energy resources rank second in the world, after those of the Sahara Desert in Africa. More than 14.38 million yuan has been invested in tapping solar energy on the highlands in the past 20 years. By 1983, Tibet had built 115,000 square meters of hothouses and 40 bathhouses heated with solar energy, totalling 6,000 square meters.

A large amount of funds has been allocated to tap energy resources in Tibet since the 1950's. Technicians and scientists have been sent by other areas of China to help survey energy resources and build power stations and other power projects in Tibet.

CSO: 4010/11



## SUPPLEMENTAL SOURCES

### BRIEFS

JIANGXIA TIDAL POWER STATION--The Jiangxia tidal power station in Wenling Xian is currently the largest such station in China. With an installed capacity of 3,900 kilowatts, it is the second biggest tidal power station in the world after the Rance facility in France. Of its planned six flow-through hydraulic turbine generators, the first was patched into the grid in May 1980. In 4 years of normal operations, it has functioned beautifully, generating more than 1.2 million kilowatt-hours a year. The second generator began to produce electricity in the early part of this year. The remaining generators will be installed and in operation by 1985. Tidal power is a hot subject internationally in today's new technological revolution. All of the equipment in the Jiangxia tidal power station is entirely of Chinese design, manufacture, and installation. [Excerpt] [Hangzhou ZHEJIANG RIBAO in Chinese 23 Oct 84 p 2 ]

CSO: 4013/42

## CONSERVATION

### LIAONING COMPLETES MAJOR CONSERVATION PROJECTS, PLANS MORE

OW110754 Beijing XINHUA in English 0651 GMT 11 Nov 84

[Text] Shenyang, 11 Nov (XINHUA)--Nearly 100 energy conservation projects have been completed in the heavy industrial center of Liaoning Province in northeast China since the beginning of this year.

This included a project to recover coal gas from blast furnaces and coke ovens and two power plants that use exhaust heat from the Fushun Chemical Plant and a carbon black plant.

The 3.2-million-yuan coal gas recovery project, financed by the state, is able to recover 27,000 tons of coal gas annually. The two exhaust heat power plants can generate 30 million kilowatt-hours of electricity a year.

Energy conservation has been made a central task in energy-short Liaoning Province. This year, the province invested 103.2 million yuan in building 155 energy conservation projects. Over 80 percent of the investment will be spent by the end of this year, according to the provincial economic commission.

The commission said that from 1980 to the present, the province has installed power generating units with a combined capacity of 30,000 kilowatts to utilize industrial heat and the annual electricity output is estimated to reach 150 million kWh. In addition, the installation of centralized heating systems helped save 430,000 tons of standard coal and 80 million kWh of electricity a year, the commission said.

The technical transformation projects in some glass works have helped reduce oil consumption for every ton of glass produced from the original 400 kilograms to 280 kilograms. Earlier, the province rebuilt 126 industrial boilers and kilns, saving 140,000 tons of standard coal annually. The oil consumption of oil refineries has been reduced from 75 kilograms in 1980 to 36 kilograms for every ton of crude oil refined, saving an estimated 190,000 tons of oil and 93,000 tons of coal annually.

A number of rural power grids and small cement plants have been revamped.

The province has planned another 44 major energy conservation projects for 1985, with a projected investment of 80 million yuan. They will include the technical transformation of steel rolling mills, cement kilns, and heat supply systems in the machine building industry.

CSO: 4010/23

## CONSERVATION

### BRIEFS

GANSU CUTS ENERGY CONSUMPTION--Gansu Province has ranked among the advanced throughout the nation in reducing energy consumption. With the completion of 22 items of technical renovation which the state has assigned to the province, the province will be able to save some 91,000 tons of standard coal. The majority of these items have been completed. Since the completion of the modification of the 650-type heating furnace in the Lanzhou Steel Plant, the plant has saved some 22,000 tons of oil, whose value is equal to more than four times the amount of investment in its modification. [Summary]  
[Lanzhou Gansu Provincial Service in Mandarin 1100 GMT 8 Nov 84 HK]

CSO: 4013/32

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